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The effect of different kinds of instant fascial release techniques for improvement of range of motion and muscle stiffness

PhD Thesis

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Abstract

Title: The effect of different kinds of instant fascial release techniques for improvement of range of motion and muscle stiffness

Objectives: This research aims to critically evaluate the effectiveness of immediate fascial release techniques such as tissue flossing (TF) and foam rolling (FR), on range of motion (ROM), viscoelastic properties of the muscle, dynamic stabilization and jump performance among athletes and fitness enthusiasts.

Methodology: Cross-over design of the study, where all participants underwent three types of conditioning: tissue flossing, foam rolling or control. The study used a comprehensive methodology that included an active knee extension test, a Y-balance test, jump performance was measured using force plates and viscoelastic properties of Biceps Femoris (BF), Rectus Femoris (RF) and Vastus Lateralis (VL) of both legs were used to assess the impact of TF and FR conditionings. Participants were measured before conditioning and respectively in 2nd and 15th minute after conditioning activity. Two-way repeated measures ANOVA was used to evaluate the data.

Results: Tissue flossing and foam rolling significantly improved ROM in both legs when compared to the control group, however no significant differences occurred between any of the conditions. Jump height experienced a significant drop post-intervention in the FR group, while no changes were observed for TF and the control group. Braking Rate of Force Development showed significant improvement in the TF group when compared pre and post max value. Dynamic stability improved significantly in both legs for the TF group and in the left leg for the FR group, with no changes observed in the control group. ANOVA analysis revealed no significant differences between the interventions in measurements of viscoelastic properties, and none of the interventions showed significant improvements when compared to the control condition. However, TF had significantly decreased muscle stiffness in right VL, both RF whereas FR significantly decreased muscle stiffness and muscle tone in all muscles.

Keywords: Tissue flossing, foam rolling, viscoelastic properties, myofascial release, performance

Shortcuts:
TF/FLOSS – Tissue Flossing
FR – Foam rolling
CON – Control
ROM – Range of Motion
SE – Standard Error
SD - Standard Deviation
ANOVA – Analysis of variance
RFD- Rate of Force development
BF- Biceps Femoris Caput longum
VL – Vastus Lateralis
RF – Rectus Femoris
R – Right leg
L – Left leg
GTO – Golgi Tendon Organ
CMJ – Countermovement jump
IASTM - Instrument-assisted soft tissue mobilization
RFE - Residual Force Enhancement
PFE - Passive Force Enhancement
CNS - Central Nervous System
MRT - Myofascial Release Techniques
DOMS - Delayed Onset Muscle Soreness
FDM - Fascial Distortion Model
TB - Trigger Band
HTP - Herniated Trigger Points
CD - Continuum Distortion
CTD - Cumulative Trauma Disorder
ART - Active Release Technique
EMG – Electromyography
BFR - Blood Flow Restriction

HR – Hold Relax

PROM - Passive Range Of Motion

AROM - Active Range Of Motion

CR – Contract Relax

CRAC - Contract Relax, Agonist Contract

PIR - Post-Isometric Relaxation

PFS - Post-Facilitation Stretching

MET - Medical Exercise Therapy

PNF - Proprioceptive Neuromuscular Facilitation

WBLT - Weight Bearing Lunge Test

DF – Dorsiflexion

SWE - Shear Wave Elastography

VAS - Visual Analogue Scale

K_{vert} - Vertical Stiffness

K_{joint} - Joint Stiffness

K_{leg} - Leg Stiffness

SJ - Squat Jumps

YBT - The Y-Balance test

Min - minimal value

Max - maximum value

AKE - Active Knee Extension

COMP - Composite Reach Score

BF - Body Fat

ASIS - anterior superior iliac spine

ANT – anterior

YBT-LQ - Y Balance Test-Lower Quarter

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1. Introduction

Fascial release techniques have been increasingly used by athletes, fitness enthusiasts, and healthcare professionals to improve range of motion and reduce muscle stiffness. Fascia is a connective tissue that surrounds and supports muscles, organs, and other structures in the body. It is responsible for transmitting force and movement between different parts of the body and plays an important role in movement and mobility (1). However, when fascia becomes restricted or damaged, it can lead to stiffness, pain, and reduced mobility.

Immediate fascial release techniques aim to alleviate these symptoms by applying pressure to the fascia and surrounding tissues to release tension and restore mobility. These techniques include tissue flossing, foam rolling, instrument-assisted soft tissue mobilization (IASTM), and others. While these techniques have gained popularity in recent years, their effectiveness in improving range of motion and reducing muscle stiffness remains a subject of debate.

This paper will explore the effects of different types of immediate fascial release techniques on range of motion, muscle stiffness and jump performance. We will examine the benefits and limitations of tissue flossing (TF) and foam rolling (FR) and compare their effectiveness in improving mobility and reducing stiffness. By understanding the mechanisms and effects of each technique, we can gain a better understanding of how to use fascial release techniques to optimize physical performance and reduce the risk of injury.

2. Theoretical background

2.1. Human anatomy- human tissues

Human tissues are specialized groups of cells that work together to perform specific functions in the body. There are four primary types of human tissues: epithelial, connective, muscle, and nervous tissues.

- Epithelial tissue: Epithelial tissue covers the surfaces of organs and lines body cavities, forming a protective barrier. It can be classified into different types based on its structure and function, such as simple squamous epithelium, stratified squamous epithelium, and columnar epithelium. Epithelial tissue serves various functions, including absorption, secretion, and protection of underlying tissues.

- Connective tissue: Connective tissue provides support and connects different parts of the body. It includes a wide range of tissues such as bone, cartilage, adipose (fat) tissue, blood, and tendons. Connective tissue functions to provide structural support, maintain shape and integrity of organs, protect delicate structures, store energy, and facilitate communication between cells.
- Muscle tissue: Muscle tissue is responsible for movement in the body. There are three types of muscle tissue: skeletal, smooth, and cardiac. Skeletal muscle is attached to bones and is responsible for voluntary movements such as walking and lifting weights. Smooth muscle is found in the walls of organs such as the digestive tract and blood vessels and is responsible for involuntary movements. Cardiac muscle is found only in the heart and is responsible for the rhythmic contractions that pump blood.
- Nervous tissue: Nervous tissue forms the brain, spinal cord, and nerves, and is responsible for transmitting and processing signals in the body. Nervous tissue includes neurons, which are specialized cells that transmit nerve impulses, and glial cells, which support and protect neurons.

These four types of tissues work together to form the complex structure and function of organs and systems in the human body, allowing for its proper functioning and maintenance of overall health (2). The field of fascia research is still in its early stages, with many unknowns that require further exploration. As technology advances, we are gaining a better understanding of the role and structure of fascia. However, there is currently a lack of integration between the scientific literature on fascia mobility, proprioception, and myofascial pain (1) and how different methods of myofascial release actually affects tissue. Nonetheless, these areas have great potential to contribute to each other and offer valuable insights into the field.

2.2. Skeletal muscle

Skeletal muscle is one of the three types of muscles found in animals, alongside heart and smooth muscles. It constitutes a significant portion of the animal body and is responsible for powering animal movement. Skeletal muscle is under voluntary control, meaning it is controlled by nerves that respond to conscious commands. One unique characteristic of skeletal muscle is its ability to generate maximal tension that remains constant over time when stimulated at a sufficiently high frequency, a state known as tetanus. This phenomenon is considered to reflect the maximal activity of the muscle's contracting mechanism. Muscle tissue serves three main functions: contraction, extensibility, and elasticity. Contraction is an active and energetic process in which muscles actively shorten and generate force with exception of tetanic contraction where no changes in muscle length are observed. At the same time, muscles have the ability to elongate within a certain range without sustaining injury. After contraction or elongation, muscles can return to their original shape. Muscle tissue consists of longitudinal chains of muscle cells, which contain numerous contractile elements called actin and myosin filaments. During muscle contraction or relaxation, these filaments slide past each other. Myosin filaments are thicker, while actin filaments are thinner and lie between the myosin filaments (3).

The mechanical behaviour of a fully activated muscle fiber is influenced by the external load applied to it. During an isometric tetanus, when the muscle fiber reaches a plateau of force production, the isometric force generated by the fiber is counteracted by the reactive force of the tendon attachments at its ends. When the reactive force matches the isometric force, the fiber maintains a constant length, resulting in an isometric contraction. If the external load is reduced to a value lower than isometric force, the fiber initiates a shortening process. This type of contraction is known as an isotonic contraction. In an isotonic contraction, the muscle fiber actively shortens while maintaining a constant tension level. In summary, during an isometric tetanus, the muscle fiber generates an isometric force that is balanced by the reactive force of the tendons, leading to a constant fiber length. When the external load is decreased below the isometric force, the muscle fiber undergoes an isotonic contraction, actively shortening while maintaining a consistent tension (4). The sliding of filaments and muscle activation requires an adequate supply of minerals (such as calcium, potassium, and magnesium) and ATP (adenosine triphosphate). These components facilitate the interaction between actin and myosin, enabling muscle contraction and relaxation (5).

The study of muscle mechanics has revealed complex phenomena like Residual Force Enhancement (RFE) and Passive Force Enhancement (PFE). RFE describes how a muscle's isometric force increases when it is actively stretched, compared to a purely isometric contraction at the same length and activation level. On the other hand, PFE refers to the elevated passive force observed in a muscle after it has been actively stretched and then deactivated (6). Research by Herzog has shown that PFE is not only a long-lasting effect but also one that intensifies with the magnitude of the stretch and the final length of the muscle. Interestingly, this effect can be instantly negated by quickly shortening the muscle to its pre-stretch length (7). These findings offer the first direct evidence that a passive component, likely Titin, plays a role in the RFE property of skeletal muscles (8). Titin is a crucial structural protein in muscle tissue, accounting for over 95% of the passive force in myofibrils. It serves multiple mechanical functions, including providing passive force, stabilizing myosin filaments, and maintaining the stability of sarcomeres particularly in the descending limb of the force-length relationship. In summary, Titin is more than a mere structural element; it is an active player in muscle function, influencing both its passive and potentially active properties (9). Despite these advances, many questions remain unanswered in this field, especially concerning the exact mechanisms through which Titin contributes to both PFE and RFE .

Muscles also contain free nerve endings and two types of specialized receptors: muscle spindles and Golgi tendon organs (GTO). Muscle spindles measure muscle length, while Golgi tendon organs are tension receptors located within the tendons. Both types of receptors, known as proprioceptors, are sensitive to stimuli within the musculoskeletal system. They play a crucial role in detecting changes in muscle tension and length, providing feedback on these relationships and contributing to motor control and coordination (10).

The motor system controls many reflexes where my focus is on muscle-afferent reflexes. Two feedback systems, both involving muscle afferents, regulate force and muscle length through reflexes. Muscle spindle afferents transduce muscle length, whereas GTO afferents transduce muscle force (11).

2.2.1. Force Feedback

The GTO functions as a relay system, providing information about the levels of force within a muscle or tendon to the central nervous system. It is composed of small inhibitory mechanoreceptors located near the junction of the muscle and tendon. The GTO monitors the amount of tensile force applied to the tendon structure. Each Golgi tendon organ consists of bundles of tendon fibers surrounded by a layered capsule, with dendrites (fine branches of neurons) winding around and between the fibers. The organ is activated by muscular contractions or stretching of the tendons. As a result, it inhibits the alpha motor neurons that innervate the contractile elements of the same skeletal muscle, leading to muscle relaxation. This mechanism helps protect the muscle and connective tissue from excessive loading and potential injury (12). The reflex triggered by the Golgi tendon organ is known as the "inverse myotatic reflex" or "autogenic inhibition." It was previously thought that GTOs were stimulated primarily by prolonged muscle stretches, but they are now recognized as sensitive detectors of tension in specific parts of a muscle as well (13).

2.2.2. Length Feedback

In contrast to GTOs, muscle spindles are aligned in parallel with extrafusal muscle fibers and have contractile elements activated by gamma motor neurons. Muscle spindles are sensitive to both the rate of stretch (phasic stretch) and the degree of stretch (tonic stretch) applied to a muscle. When muscle spindles are stimulated by stretch, they trigger a contraction in the stretched muscle, which is known as the myotatic reflex or stretch reflex. Simultaneously, they inhibit action potentials to antagonistic muscles. Muscle spindles play a role in regulating muscle tone, contributing to the overall control and coordination of muscle activity (12). Without efferent innervation, muscle spindles would slacken when extrafusal fibers shorten. As a result, the spindle afferents would become silent, leading to a loss of information about muscle length. To maintain this information flow, gamma motor neurons activate the muscle spindles during contraction. During movement and steady posture, muscle spindle afferents sense muscle length relative to a bias length set by their gamma motor neurons. When gamma motor neuron activity is high, the bias length is relatively short. If the muscle length exceeds this bias length, muscle spindle afferents increase their discharge rate, exciting the alpha motor neurons that innervate the same muscle. This increased activity tends to shorten the muscle, bringing it closer to the bias length. Overall, gamma motor neuron activity allows the central nervous system (CNS) to control the sensitivity of muscle spindle afferents, which plays a crucial role in regulating muscle stiffness (11).

Muscle spindles are especially crucial in sensing muscle length. The main function of stretch reflexes is to generate responses to unexpected perturbations. If the arm is suddenly displaced during a movement, both the short-loop and long-loop reflexes elicit compensatory responses. These reflexes alter the activation levels of motor neurons, stabilizing and stiffening the limb as it follows its intended trajectory. Reflexes aid the motor system in overcoming unfamiliar obstacles (11).

It is hypothesized that tissue flossing cause dissipation of myofascial adhesions along the muscle without affecting actual tissue length or negatively affects the priming of Golgi tendon organs (GTOs) and muscle spindles.

2.3. Fascia

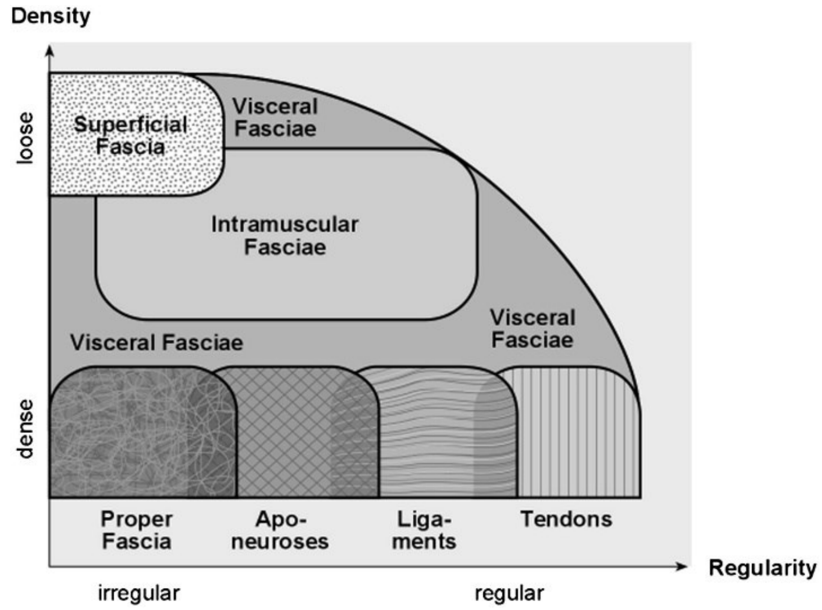
2.3.1. Histological/anatomical definition of "a fascia"

Fascia refers to a sheath, sheet, or aggregations of connective tissue that is located beneath the skin and serves to attach, enclose, and separate muscles and internal organs in the body (14).

2.3.2. Functional definition of the fascial system

The fascial system is a three-dimensional continuum of soft connective tissue made up of loose and dense collagen fibers that permeate the body. It encompasses various elements such as adipose tissue, adventitiae and neurovascular sheaths, aponeuroses, deep and superficial fasciae, epineurium, joint capsules, ligaments, membranes, meninges, myofascial expansions, periostea, retinacula, septa, tendons, visceral fasciae, and all the intramuscular and intermuscular connective tissues, including endomysium, perimysium, and epimysium (Fig 1). This fascial system surrounds, interweaves between, and interpenetrates all organs, muscles, bones, and nerve fibers in the body. It provides a functional structure and creates an environment that enables all body systems to operate in an integrated manner, playing a crucial role in maintaining overall body function and movement coordination (14).

Fig 1. The different types of connective tissues (Source: (15))



2.3.3. Fascial restrictions

Fascial restrictions can develop due to various factors such as inactivity, excessive strain, injuries, inflammation, and diseases. These factors can individually or collectively contribute to an increase in stiffness within the connective tissue (16):

- Sustained volume changes of the muscle: When muscles undergo hypertrophy or become hypertonic (excessively tense), the fascia surrounding them can experience radial expansion, which affects its mechanical properties (17).
- Direct fiber insertions: In certain areas, skeletal muscles have direct connections with the deep fascia surrounding them. These connections allow for selective tensioning of the fascia in specific regions (18).
- Contraction of myofibroblast cells: Myofibroblast cells play a role in fascial tone and are influenced by the autonomic nervous system. Psychological stress can lead to long-term increases in fascial tone through the contraction of these cells (19).
- Fascial hydration changes: Mechanical stimuli like stretching exercises can cause alterations in fascial hydration. The water content of the fascia is

directly linked to its stiffness, so changes in hydration can impact the mechanical properties of the connective tissue (20).

In addition to general tissue stiffening, myofascial trigger points (MTrPs) are a specific pathological condition associated with the connective tissue. Dehydration of the fascia, which reduces its elasticity, can cause the myofascia to bind around injured areas, resulting in the formation of fibrous adhesions (21, 22). These adhesions can give rise to "hypersensitive tender spots" or trigger points (23). A trigger point is characterized as the most sensitive and irritated location within a taut band of muscle, causing increased sensitivity of pain receptors in that area. Fibrous adhesions can be painful and can disrupt normal muscle function, including muscle strength, activation, endurance, coordination, as well as limit the extensibility of soft tissues, thereby impairing joint range of motion and muscle length (21-23).

2.4. Myofascial release

2.4.1. History of myofascial release

Andrew Taylor Still, MD, who founded osteopathic medicine in 1874, was one of the first sports medicine physicians in the United States. At the American School of Osteopathy in Kirksville, Missouri, he believed in connection between being healthy and exercising. An anatomist by avocation, Dr. Still observed the connection between structure (anatomy) and function (physiology) in normal and pathologic states and promoted of osteopathic medicine: the body is a unit, seen as whole system not particular joints; structure and function are reciprocally interrelated; and the body is self-healing. Those states became the fundamentals of school of osteopathy. In founding osteopathic medicine, Dr. Still was working with promoting his philosophy that structure and function are interconnected and thus that they affect the work and capabilities of the body (performance). According to Robert Ward, myofascial release originated from the concept by Still who called it in that point “fascial twist”. Mr. Ward also suggested that the term “myofascial release” as a technique was coined in 1981 when it was used as a course title at Michigan State University. German physiotherapist Elizabeth Dicke developed connective tissue massage (German: Bindegewebsmassage) in the 1920s, which involved superficial stretching of the myofascia. However, the official label of myofascial release was the term myofascial was published in medical literature by Janet G. Travell, M.D. in the 1940s in reference to musculoskeletal pain syndromes and trigger points. In 1976, Dr. Travell began using the term “myofascial trigger point” and in 1983 published the reference Myofascial Pain & Dysfunction: the Trigger Point Manual (Travell & Simons, 1983).

Nowadays thanks to new devices there are more possibilities to understand the phenomenon of the fascia and improve treatment methods. Stecco findings about fascia are bringing innovations and new light to this topic. Researchers are still trying to discover new methods and devices which will help us understand it better.

2.4.2. Myofascial release techniques (MRT)

There are many myofascial techniques which are generally falling under the two main categories of passive (patient stays completely relaxed) or active (patient provides resistance as necessary), with direct and indirect techniques used in each.

2.4.2.1. Direct myofascial release

The direct myofascial release technique involves applying significant pressure to areas of tissue that are restricted, with the goal of promoting relaxation in these areas. This pressure can be applied using various methods, such as using the therapist's hands, elbows, or tools. The technique aims to bring about changes in the myofascial structures by stretching and elongating the fascia, as well as by mobilizing adhesive tissues. The therapist will move slowly and with great precision to work through all the layers of the fascia.

Chosen methods depends on practitioner preferences and experience. The applied pressure should be adjusted to the patient, however with keeping in mind that higher applied pressure develop the healing process to the greater degree (24).

2.4.2.2. Indirect myofascial release

The indirect method involves a gentle stretch, with low applied pressure, which allows the fascia to ‘unwind’ itself. The dysfunctional tissues are moved along the path of lowest resistance until free movement is achieved. The small traction is applied to the restricted fascia which results in increased temperature and due that increased blood flow in that spot. This activates the body's self-healing and lead to self-correction, thus eliminating pain and restoring the optimum performance of the body.

2.4.3. Description of the techniques

2.4.3.1. Foam rolling (FR)

Foam rolling is performed by the individual themselves using a tool (Fig 2). The most common tools used are the foam roller and roller massager. FR appears to have a wide range of effects. It is the most popular for increasing flexibility acutely and chronically, by reference to changes in joint range of motion (ROM) (25) Previous studies indicated ROM increase in short-term (26, 27) or up to 20 minutes (28, 29). Although it has also used to reduce delayed onset muscle soreness (DOMS) (30), affect arterial function and vascular endothelial function, and modulate autonomic nervous system activity (Beardsley & Škarabot, 2015). It is commonly used by athletes, especially by runners to release the soreness after training. However, the full mechanism of foam rolling remains not fully known. There are few potential mechanisms which can cause beneficial effect of therapy: thixotropy, piezoelectricity, fascial adhesions, cellular responses, fluid flow, fascial inflammation, and myofascial trigger points (31).

FR is considered to have similar effect to massage therapy, therefore it is speculated that sustained pressure causes excitation of mechanoreceptors of nervous system, most probably Golgi Tendon Organ (GTO). Muscle stiffness is perceived by this mechanoreceptor, therefore when applying pressure, the GTO is sending the impulse to the nervous system which leads to muscle relaxation by overriding muscle spindle. A muscle spindle is a mechanoreceptor which is responsible for muscular contraction when it perceives that tissue is being stretched too rapidly or too far (32). Other neurophysiological mechanism involves Ruffini and Pacini corpuses and interstitial muscle receptors, which are commonly found in fascia (Stecco et al., 2007). Moreover, FR is expected to have similar benefits as massage in relieving exercise-induced muscle damage which causes DOMS (30). Improvement occurs through changing a muscle's viscoelastic properties, increasing mitochondria biogenesis and increasing blood flow possibly by increasing angiogenesis and vascular endothelial growth factor (Pearcey et al., 2015; Schroeder & Best, 2015). Another beneficial side of FR is decreasing inflammation in the muscle, most probably by changing in tissue gene expression along with variable effects on limb circumference and increased blood flow (Best, Gharaibeh, & Huard, 2013) (Crane et al., 2012). Fascia also consists of the water, which is an important factor during fascia sliding and therefore affects its stiffness. Foam roller cause temporary tissue dehydration which result with renewed hydration (Chaitow, 2009; Schleip & Müller, 2013). Another mechanical mechanism of FR is piezoelectricity which suggests that fibroblast and fibroclasts are responding to electric charges which occur during applied pressure (Connell, 2003).

Several studies have reported decreased muscle stiffness after foam rolling (33, 34), which leads to lack of improvement in jump performance (35).

Fig 2. Foam rolling release tools (Source: https://nsga.com/self-myofascial-release/)

2.4.3.2. FDM – Fascial Distortion Model

The Fascial Distortion Model (FDM) is a method used for treating mostly, but not only, musculoskeletal system. Model, developed by American doctor: Steven Typaldos, assigns the cause of physical afflictions and impaired motor function to one or several of six typical forms of fascial distortion in the human organism: trigger bands, herniated trigger points, continuum distortions, folding distortions, cylinder distortions and tectonic fixations.

FDM diagnostic process contains three basics pillars. The first one and the most important is patient’s body language during interview and examination. Intuitive gestures, if properly interpreted, are indicators of fascial distortions. Detailed medical history is also an important factor during diagnostic process (36).

Description of fascial distortions:

- Trigger band (TB): Distorted fascial band

The most common of all, trigger bands are twisted or wrinkled fascial fibers that cause a burning or pulling pain along fascial structures that are comprised primarily of linear fibers (such as fascial bands, ligaments, and tendons). Patients who suffer from TB injuries usually during interview are sweeping injured spot with their fingers (37).

- Herniated Trigger points (HTP): Abnormal protrusion of tissue through the fascial plane

HTP’s are tiny pathological herniations of tissue through a fascial plane most commonly found along the top of the shoulder (supraclavicular fossa) and deep in the buttock (bullseye). They can also be found along the edge of the scapula, deep in the tissues of the arm and thigh, and in the pelvic floor. The associated patient body language is a pushing of the tender area with the fingers (subconscious attempt at reduction of the herniation) (37).

- Continuum Distortion (CD): Alteration of transition zone between ligament, tendon, or other fascia and bone

Continuum distortions cause a pain in one certain spot which patient can easily point with the finger (but do not push on it or rub the involved area). There might be single CD or culmination of few CD points (commonly seen in plantar fasciitis and sprained ankles) (37).

- Folding Distortion: Three-dimensional alteration of fascial plane

Folding injuries commonly occur in tissue around joints and are similar to what happens to a road map that unfolds and then refolds in a contorted condition. Chief verbal complaint expressed is “aching pain deep in the joint.” These are the joints that tend to swell or ache more when the weather changes (37).

- Cylinder Distortion: Overlapping of cylindric coils of fascia

Cylinder distortions cause pain in non-jointed areas (and to a lesser extent in jointed areas) which cannot be reproduced or magnified with palpation. They are also responsible for a wide range of untypical symptoms, such as tingling (paresthesia), numbness (diminished sensation), and pain that spontaneously seems to jump from one location to another. Cylinder distortions can also cause weakness or spasm in the trunk or extremities. Because the cylinder fascia is interconnected, cylinders can spread and jump to seemingly unrelated areas of the body (37).

- Tectonic Fixation: Inability of fascial surfaces to glide

Stiffness of the joint is a description of a tectonic fixation. Thrusting manipulations (as performed by chiropractic adjustments or osteopathic high velocity manipulation, as well as orthopedic manipulation under general anesthesia) are typical current and widely practiced methods of correcting tectonic fixations. However, in the FDM other manipulative, non-manipulative, medical and surgical approaches are being designed and applied so that even the most stubborn frozen shoulders or stiff backs can be quickly and adequately treated (38).

2.4.3.3. Active release technique (ART)

Active release technique is a method for treatment of soft tissue lesions includes placing a contact point near the lesion and causing the patient to move in a manner that produces a longitudinal sliding motion of soft tissues, e.g., nerves, ligaments, and muscles, beneath the contact point. Treatments are continued at Sequential time intervals until the symptoms produced by the lesions are alleviated. This therapy is used for treating soft tissue problems in muscle, joints, and connective tissues (W George, C Tunstall, Tepe, & D Skaggs, 2006). ART is based on the theory of cumulative trauma disorder (CTD). CTD appears after acute soft tissue injury, repetitive injury, or a constant pressure/tension injury. CTD usually occurs due to weakness or tightness of the muscle which produces an increase in internal forces acting on the tissues, such as friction, pressure, or tension. This increase in force decreases circulation, thus causing edema. This issue, when not treated, is repeating all the time and that leads to soft tissue disorders such as peripheral nerve entrapment, epicondylitis, and tenosynovitis and may lead to strength differences and muscle inhibition in the affected musculature (Drover, Forand, & Herzog, 2004).

2.4.3.4. Instrument assisted soft tissue mobilization techniques (IASTM)

Instrument assisted soft tissue mobilization (IASTM) is a popular treatment for myofascial restriction based upon the rationale introduced by James Cyriax. Unlike the Cyriax approach utilizing digital cross friction, IASTM is applied using specially designed instruments (Fig 3) to provide a mobilizing effect to soft tissue (e.g., scar tissue, myofascial adhesion) to decrease pain and improve range of motion (ROM) and function. Instrument allows physician to penetrate deeper-located tissues and apply more specific treatment. Beneficial side of this method is reduced stress for therapist’s hands. Instrument let experienced physician feel vibrations which are helping to detect altered tissues properties (e.g., tissue adhesions). IASTM stimulating tissue remodelling through resorption of excessive fibrosis, along with inducing repair and regeneration of collagen secondary to fibroblast recruitment. In result, it cause disintegration of scar tissues, adhesions and fascial restrictions (39). In laboratory studies with using rat model, this model increased fibroblast proliferation and collagen repair in cases of enzyme induced tendinitis (40, 41) Loghmani in his laboratory, working on rat muscles, proved that IASTM accelerated ligament healing, possibly via favorable effects on collagen formation and organization. Moreover, it produced a significant short-term increase in ligament strength and stiffness compared to the control limb (42).

Fig 3. Tools used for IASTM (Source: https://kovacsinstitute.com/recommendedproducts.html)

2.4.3.5. Medical flossing (Tissue Flossing)

Medical flossing (also known as voodoo flossing/tack and floss method) is a technique that purportedly improves ROM, enhances the prevention or rehabilitation from injury, reduces muscle tension, and improves athletic performance (43). It is defined as an intermittent, compression-based joint mobilization method that incorporates active and/or passive movement through functional positions, mobilizing the joints and soft tissues including fascia in that (44).

2.4.3.5.1. Tissue flossing material

Flossing bands are made of 100% natural rubber and come in different lengths ranging from approximately 1.03 to 2.06 meters. The material thickness varies from 1.1 mm to 1.6 mm. Bands used on arms, legs, and the body are 5 cm wide, while narrower bands measuring 2.5 cm in width are available for use on small joints and hands. The quality of the bands is crucial for effective treatment, and factors such as surface grip and elasticity are important considerations.

A well-fitting band that clings to the skin optimally is essential for achieving the desired therapeutic stimulus in the tissues and target structures. The bands should have uniform elasticity, allowing for precise tension adjustment according to the specific structures being manipulated. Flossing bands are typically free of softeners and other toxic substances, making them safe for use on the skin. However, it's important to rule out any allergies to rubber before using them. If a rubber allergy is present, the flossing band may be applied over clothing for safety.

2.4.3.5.2. Possible mechanism of action

Blood flow and tissue drainage

Currently, there are limited scientific studies on flossing, and its exact mechanism of action is not yet fully understood. While there are several potential effects of flossing, the compression of the flossing bands is not the only factor at play, as additional movements are typically performed during the treatment. When the flossing band is tightly applied, it immediately reduces blood flow in the treated area and squeezes out tissue fluid due to the elastic ligature. The subsequent loosening of the ligature leads to enhanced blood flow, similar to a sponge effect. Metabolic by-products are expelled through the compression and washed out during the subsequent hyperemia. The compression is typically released after 1-2 minutes, allowing blood and lymph to circulate freely again. In terms of the lymphatic system, it is speculated that the pressure from flossing may help transport swellings to regions with functional lymphatic systems. Recent studies suggest that higher pressures, around 120 mmHg (equivalent to 0.16 kg/cm^2), may be optimal for reducing edema when transient compression is repeated multiple times (45, 46). However, there are currently no specific studies on the mechanisms of action of lymphatic drainage in flossing, and further research is needed in this area.

Skin and fascia network

The skin, being in direct contact with the flossing band, conducts stimuli to the central nervous system through numerous receptors. Intensive flossing treatment of the skin leads to powerful stimulation of mechanoreceptors, and the conduction of these stimuli to the brain can result in suppression of pain signals in the spinal cord. This increased input also enables the nervous system to compensate for discrepancies and imbalances.

The fascial network, beginning directly below the skin, is abundantly supplied with nerve fibers and receptors, making it the body's largest sensory organ. Fascia links all the organs in the body, forming a continuous network from head to foot and from the outside in. The mobility of individual fascial layers and their relationship with neighbouring structures such as tendons, muscles, ligaments, blood vessels, and nerve fibers is a central element in fascial health. However, injuries, surgery, and lack of exercise can lead to adhesions and impairments in the fascia. When viewed as a treatment for fascia, flossing can be particularly effective following surgery and injuries. The pressure applied by the band, combined with movement, generates shear forces that hold the individual fascial layers in place from the outside, while active movement loosens adhesions between the layers. Furthermore, compression and stimulation of mechanoreceptors have been shown to improve fluid supply to the extracellular matrix or "ground substance" of fascia (47). This increased water content reduces viscosity and enhances mobility. The remarkable efficacy of flossing in patients who have undergone surgery in the past, may be attributed to the restoration of fascial mobility. Similarly, persistent long-term effects of flossing may be associated with improved fascial integrity, as the compression and movement help to restore normal fascial function and reduce adhesions (48).

Joints

When a joint is included in the flossing wrap, it undergoes perceptible compression. Joint capsules and surrounding ligaments contain proprioceptors, which provide the brain and vestibular system with information about joint position and stresses. Joint effusion, commonly seen after joint injuries or surgery, can cause pain and restricted mobility of the joint capsule, leading to impaired coordination and sensorimotor functions. The remarkable effects of flossing may trigger proprioceptive and sensorimotor reintegration, as evidenced by accelerated response times in muscles treated with flossing in EMG studies (49). This could explain the immediate effects observed with flossing. The direction of the band's pull can be used to exert a specific stimulus on the joint position. For instance, winding the band with the direction of pull from the inside out can result in a slight lateral displacement of the moving parts of the joint, causing distraction of certain segments of the joint during movement. Occasionally, this can lead to a release of the joint with an audible crack during the flossing movement (48).

Tissue flossing and blood flow restriction training

There is a hypothesis that flossing may yield similar results to blood flow restriction (BFR) training, as both techniques create a hypoxic environment (50). Additionally, BFR application during exercise has been shown to promote significantly greater intramuscular metabolite accumulation compared to intense resistance exercise alone (51). There are two likely mechanisms that may be responsible for BFR-induced hypertrophy: neurological effects and metabolic accumulation.

The neurological effects of hypoxia during BFR may result in accelerated fatigue, leading to the recruitment of more muscle fibers as evidenced by greater EMG activity under BFR conditions (52). The other mechanism is metabolite accumulation due to restricted venous return. The metabolic stress induced by anaerobic exercise is known to promote cellular anabolism (53), and BFR may increase hypoxic- and metabolic stress-induced hypertrophy. This means that lower resistance loads used in conjunction with BFR may produce strength gains comparable to heavy loads without the same mechanical strain (54). As a result, low-intensity resistance exercise with BFR may lead to greater post-exercise concentrations of growth hormone, norepinephrine, IL-6, and lactic acid compared to low-intensity resistance exercise without BFR. However, further research is needed to better understand the mechanisms underlying the effects of flossing and its potential similarities to BFR training.

To date, only one study has compared BFR and TF, and the results showed that TF caused similar, and even exaggerated, decreases in blood flow, accelerations in muscular fatigue, and accumulations in metabolites compared to BFR. Although the magnitudes of the effects on heart rate were not significantly different between TF and BFR, neither condition showed a significant difference compared to the control (CON) conditioning in any of the measures. However, this study demonstrated that TF resulted in significantly greater occlusion of blood flow compared to BFR set at 50% occlusion pressure. BFR at 50% occlusion pressure did not significantly differ from CON in terms of changes in arterial blood flow, whereas TF caused significantly greater reductions in flow compared to both CON and BFR. Specifically, BFR at 50% occlusion pressure caused a 12.36% reduction in volume flow at the tibial artery compared to CON, while TF caused a 32.51% reduction, more than twice as much as BFR.

One limitation of this study was that the applied pressure during TF was not measured, and only a stretching of the band by 50% was used for wrapping (55).

2.5. Evaluating methods for myofascial release techniques

Myofascial release is focused on releasing tissue restrictions through applied pressure. This pressure can be enforced by therapist or with using a tool. Nevertheless, the obtained effect is the same – fascia and all connective tissues are getting relaxed. There are many different ways to evaluate myofascial release results, depending on what is subject of interest: ROM in joints connected to released tissue, fascia and/or connective tissue/muscle itself or patient perception (like pain, joint perceive etc.). New technologies appearing all the time bringing possibilities to better understand of occurring mechanisms and measure with details outputs of treatment. Each practitioner is using available tools/knowledge for assessing the benefits of used treatment techniques however it is always better to use at least two methods so results will be reliable.

2.5.1. Range of motion (ROM)

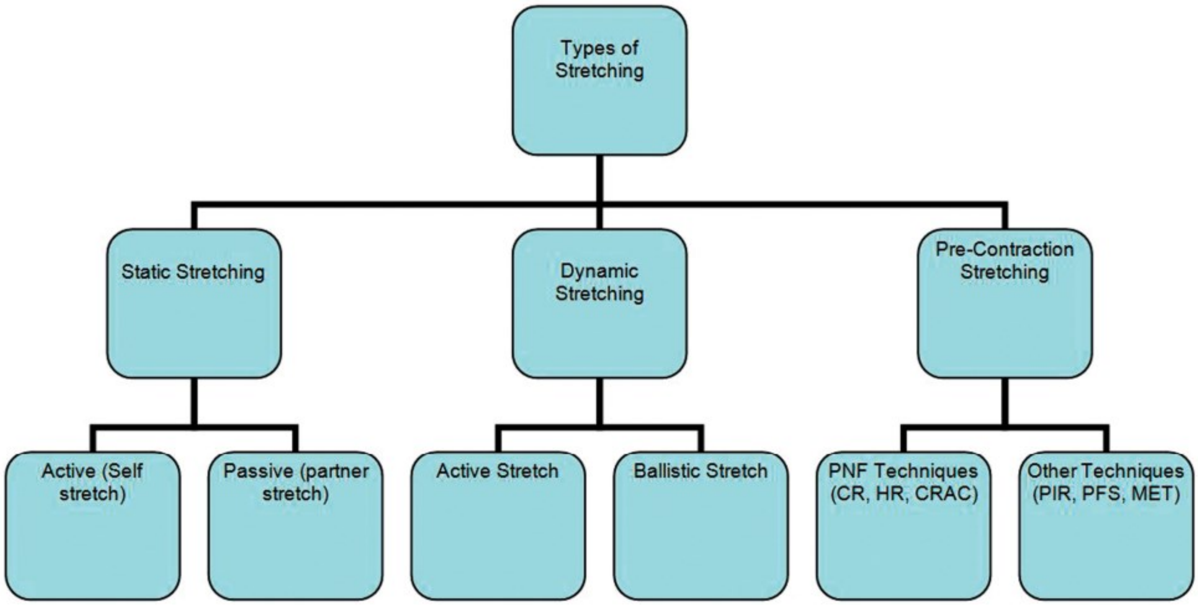
Range of motion (ROM) refers to the degree or extent to which a specific body part can be moved around a joint or a fixed point. It represents the total movement capability of a joint. During physical therapy assessments or treatments, ROM is typically evaluated through two methods: passive range of motion (PROM), which involves assisted movement, and active range of motion (AROM), which involves independent movement. The assessment of ROM is an essential aspect of physical therapy as it helps determine the functional abilities and limitations of an individual (56). Normal values for ROM vary depending on the specific body part being assessed and can also vary among individuals. ROM exercises serve several purposes in physical therapy. They aim to prevent the development of adaptive muscle shortening, contractures, and the shortening of capsules, ligaments, and tendons. These exercises also provide sensory stimulation, enhancing the body's awareness of movement and facilitating improved motor control (57). Overall, ROM exercises play a crucial role in maintaining and improving joint flexibility, preserving functional abilities, and preventing potential complications associated with limited joint mobility.

Range of motion can be limited by two main anatomical factors: joints and muscles. Joint limitations are influenced by factors such as the shape and alignment of the joint, as well as the surrounding capsuloligamentous structures. These structures contribute to the overall stability and range of motion of the joint. Muscles play a significant role in both passive and active tension, which can affect ROM. Passive muscle tension is determined by the structural properties of the muscle and the surrounding fascia. These properties include the elasticity and extensibility of the muscle fibers and connective tissues. The passive tension generated by muscles contributes to the overall resistance encountered during joint movement. Active tension in muscles is generated through dynamic muscle contractions. This active tension is a result of the neuroreflexive properties of muscle. The contraction of muscles is controlled by peripheral motor neurons, specifically the alpha motor neurons, which transmit signals from the central nervous system to the muscles. Additionally, gamma motor neurons contribute to reflexive activation and control the sensitivity of muscle spindles. The combination of passive tension from the structural properties of muscles and active tension from muscle contractions determines the overall range of motion around a joint (58).

2.5.2. Methods for improving ROM

There are various methods for increasing ROM. However, three of them are frequently described in the literature: Static, Dynamic, and Pre-Contraction stretches. Additionally, self-myofascial release is considered as an effective method to improving ROM and recently tissue flossing is also gaining popularity as described in previous chapter (Fig 4).

Fig 4. Techniques of Muscle Stretching. HR=Hold relax; CR=Contract relax; CRAC= Contract relax, agonist contract; PIR= Post-isometric relaxation; PFS=Post-facilitation stretching, MET= Medical exercise therapy. (Source: (58)).



2.5.2.1. Static stretching

Static stretching is a form of stretching in which a muscle or muscle group is slowly stretched to its maximum length and held in that position for a prolonged period, typically between 15 to 60 seconds. It is commonly performed as part of a warm-up or cool-down routine before or after physical activity.

The primary function of static stretching is to improve the flexibility and range of motion of the muscles and joints (59). By holding a stretch for an extended period, the muscle fibers gradually elongate, allowing for increased joint mobility and improved muscle flexibility (60). This can be beneficial for various activities that require a wide range of motion, such as dance, gymnastics, martial arts, and certain sports.

Static stretching has been traditionally believed to enhance performance and reduce the risk of injuries. However, recent research has suggested that static stretching immediately before high-intensity activities or sports performance may have negative effects on muscle strength, power, and explosive movements. This is known as the "stretching-induced strength loss" phenomenon (61). The mechanisms behind this performance decrement are not fully understood, but there are a few proposed theories:

Neural Inhibition: Static stretching may temporarily reduce the neural activation of the stretched muscles, leading to decreased muscle strength and power. The prolonged stretch may interfere with the ability of the muscle fibers to generate force effectively (62).

Mechanical Changes: Stretching a muscle for an extended period can cause changes in the muscle-tendon unit, including a decrease in muscle stiffness and a shift in the length-tension relationship. These alterations might negatively impact the muscle's ability to generate force and power (63, 64).

Muscle Damage: Some studies have suggested that static stretching may induce microscopic damage to the muscle fibers. This can trigger an inflammatory response and impair muscle function temporarily (65).

It's important to note that the negative effects of static stretching on performance are primarily observed when it is performed immediately before activities that require high force or power output, such as sprinting or weightlifting (66). However, static stretching can still be beneficial when performed at other times, such as during a cool-down routine after low intensity exercise or as a separate flexibility training session (67, 68). To optimize performance and minimize the risk of injury, many experts now recommend incorporating dynamic stretching and movement-based warm-up routines that mimic the movements of the activity or sport to be performed.

2.5.2.2. Dynamic stretching

Dynamic stretching is a type of stretching that involves active movements of the muscles and joints through a full range of motion. Unlike static stretching, dynamic stretching incorporates movement and momentum to gently stretch and warm up the muscles. It is commonly used as part of a warm-up routine before physical activity or sports performance

(69). The primary function of dynamic stretching is to increase body temperature, blood flow, and activate the neuromuscular system. It helps prepare the body for the specific movements and demands of the activity to follow, enhancing performance and reducing the risk of injury (69). Dynamic stretching involves controlled, repetitive movements that gradually increase in intensity and speed. When performed correctly, dynamic stretching has several functional connections to performance:

Increased Range of Motion: Dynamic stretching helps improve flexibility and range of motion by actively moving the muscles and joints through various planes of motion. This can enhance movement efficiency and reduce the risk of strains or sprains during activities that require a wide range of motion (70, 71).

Enhanced Muscle Activation: Dynamic stretching activates the muscles and neural pathways required for the upcoming activity or sport. This can improve muscle coordination, timing, and overall performance (72, 73).

Improved Neuromuscular Function: Dynamic stretching helps "wake up" the neuromuscular system by stimulating the nerves that control muscle contractions. This can improve the speed and accuracy of muscle contractions, resulting in enhanced athletic performance (74).

Increased Blood Flow and Oxygen Delivery: Dynamic stretching increases blood circulation and oxygen supply to the muscles, providing them with the necessary nutrients and removing waste products. This can optimize muscle function and delay the onset of fatigue during physical activity (75).

When incorporating dynamic stretching into a warm-up routine, it is essential to choose exercises that mimic the movements and muscle groups used in the activity or sport. This ensures that the body is adequately prepared for the specific demands and reduces the risk of injury. Additionally, it's important to perform dynamic stretches in a controlled and gradual manner, avoiding jerky or excessive movements that could strain the muscles or joints.

2.5.2.3. Pre- Contraction stretching

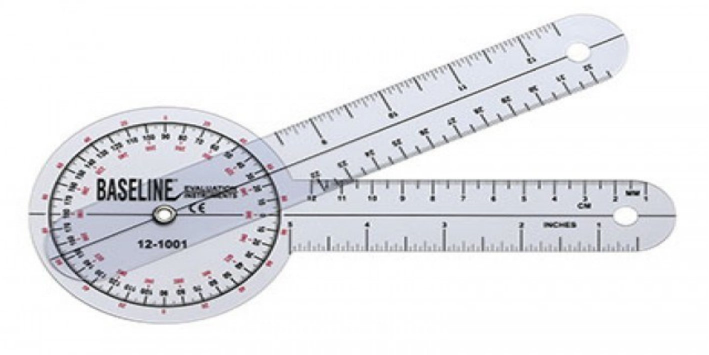
Pre-contraction stretching involves initiating a muscle contraction in either the muscle being stretched or its antagonist before proceeding with the stretching. One commonly used method of pre-contraction stretching is called proprioceptive neuromuscular facilitation (PNF) stretching. PNF stretching encompasses various techniques, including "contract relax" (CR), "hold relax" (HR), and "contract-relax agonist contract" (CRAC). During PNF stretching, the individual undergoing the stretch is instructed to contract the muscle being targeted or its antagonist at a high intensity, typically ranging from 75% to 100% of their maximum contraction. This contraction is held for approximately 10 seconds before the individual relaxes the muscle. Resistance can be applied during the contraction phase of the stretch, either by a partner providing manual resistance or by using an elastic band or strap to enhance the stretch. By engaging in pre-contraction stretching, the goal is to tap into the body's neuromuscular mechanisms to enhance the effectiveness of the stretch. PNF stretching techniques aim to promote a greater stretch tolerance and improve muscle flexibility and range of motion (76).

Range of motion measuring methods depends on joint which is aimed to be assessed. However, there are tools which are helping in evaluation of ROM such as:

2.5.2.4. Goniometer

Instrument, which is used to measure ROM of joint, shows results in degrees (Fig 5). To use properly goniometer therapist should be able to find proper anatomical spots on the body like bones etc. However, it is unsure if the goniometer is a reliable instrument to determine range of motion, mostly because it is difficult to place it in the exact same places as before. Some of the studies argue that reliability depends on the type of goniometer which is used (Hancock, Hepworth, & Wembridge, 2018; Milanese et al., 2014; Watkins, Riddle, Lamb, & Personius, 1991).

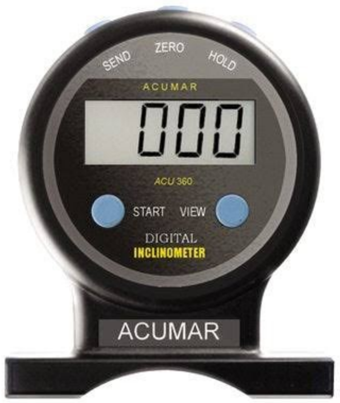
Fig 5. Goniometer (Source: (77))



2.5.2.5. Inclinometer

Instrument used for measuring angles of slope (Fig 6).

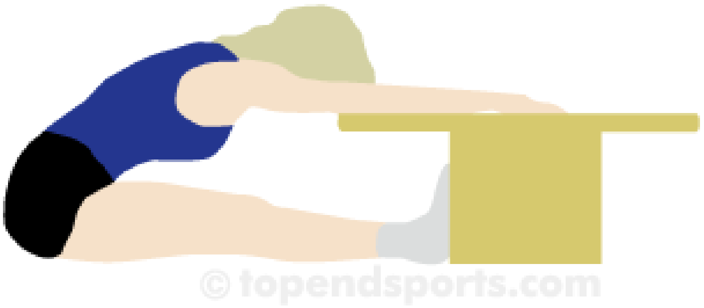
Fig 6. Digital inclinometer (Source: (77)



2.5.2.6. Sit and Reach Test

Sit and Reach (Fig 7) is linear flexibility tests which is used to measure extensibility of hamstrings and lower back. Benefit of this test is its simple procedure and not requirement of any skills (78). There are various techniques and variation of the Sit and Reach test. Most common option is patient sitting on the floor without shoes with the soles placed against the box. Both knees are fully extended. Hands are facing downwards the box and the subject reach forward along the measuring line as far as possible and stay in this position for one-two seconds, during that time distance is recorded (79).

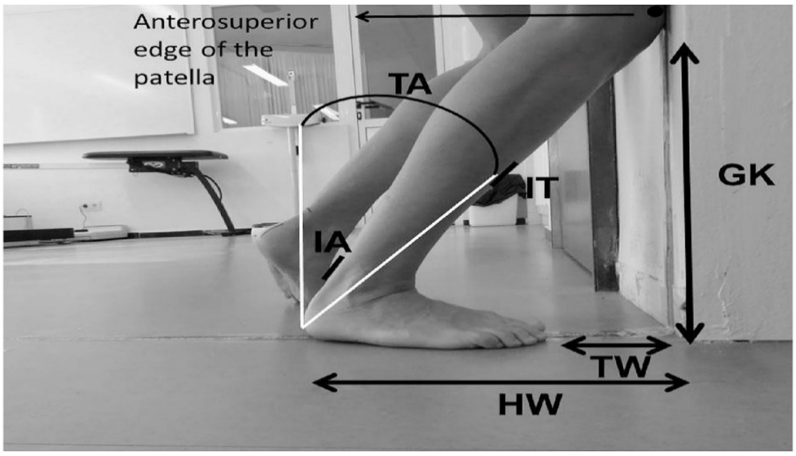
Fig 7. Sit and reach test (source: http://wyrhrf.weebly.com/fitness-assessment.html)



2.5.2.7. Weight Bearing Lunge Test (WBLT)

Weight Bearing Lunge Test (WBLT) (Fig. 8) is performed to measure the dorsiflexion (DF) ROM in ankle joint (Konor, Morton, Eckerson, & Grindstaff, 2012; Powden, Hoch, & Hoch, 2015). Methodology is not complicated and doesn’t require expensive tools, only measure tape or inclinometer. The patient is standing in front of the wall and lunge forward so the knee touches a wall. During this task, the involved foot remains firmly planted on the ground as the tibia is progressed over the talus into maximum dorsiflexion. There are three possibilities of taking results: through measuring distance from top of the toe to wall, goniometry, or trough inclinator (Picture 3). In a study performed by Bennell et al. was evaluated differences between two methods of DF ROM: one was the distance from toe to the wall, other was the angle between the tibial shaft and the vertical using an inclinometer. Inter-rater intraclass correlation coefficients (ICC) values were respectively 0.99 and 0.97. Those results indicate excellent reliability for both methods for assessing DF lunge (Bennell et al., 1998). Overall WBLT is considered as a reliable method to assess ankle DF.

Fig. 8 Weight Bearing Lunge Test (source: (80))



There are available many variations of weight bearing lounge test. Some of them focused only on hamstring mobility other on lower back mobility. Thus each variation chosen in researches all depend on desired result and available tools (81).

2.5.3. Fascia and/or connective tissue/muscle itself

2.5.3.1. Ultrasound elasticity imaging –elastography

Elastography is a non-invasive technique used to differentiate the elasticity of tissues (82). It is based on the fact that soft tissue has greater tissue displacement than hard tissue when externally compressed. Sonoelastography allows calculation and comparison of tissue displacement before and after tissue compression with conventional ultrasonography equipment but modified software (83). In medical usage, elastography requires the application of a mechanical stress to the tissues and then measurement of the displacement before and immediately after the stress as an estimate of the strain (84). Mainly there are two methods in general clinical usage:

Strain elastography

In strain, or compression elastography, a force (i.e., stress) is applied from the transducer by repetitive manual pressure and the displacement (strain) is calculated from the return velocities of the tissues with respect to time. Strain elastography has many potential disadvantages, including the variability in the pressure applied to the tissue. Thus, enough compression/decompression cycles must be performed to obtain a representative assessment, however, excessive compression may adversely affect the resulting elastograms through pre-loading the tissues (85).

Shear wave elastography

Shear wave elastography applies a vibration to tissues through a focused ultrasound pulse, generated by the transducer. This deposition of energy within the tissues creates transverse waves, or shear waves, which are perpendicular to the push pulse. The shear wave velocities can be measured from Doppler frequency modulation of simultaneously transmitted probing ultrasound waves. Young’s modulus can then be estimated as a function of the shear wave velocity. The stiffer the tissue is (the less compliant to shear forces), the faster the propagated shear waves within it (85).

Unfortunately access to SWE is limited to big hospitals and research institutes because of the price of the device. Therefore, many institutions are checking stiffness of muscle with other equipment.

2.5.3.2. Myotonometr

Myotonometr is generally a device that measures muscle tone. One of the most popular devices is Myoton PRO (Fig 9). It is a portable device which is used to measure in non-invasive way digital palpation of superficial skeletal muscles and tendons. Moreover, it is very reliable and accurate, which makes it interesting option instead of SWE (86, 87). It is a very convenient device to use in everyday medical practice to assess the results of the therapy. Feng and al. compared the accuracy of Myoton PRO with SWE, results has shown good intra-operator repeatability, which sums up that Myoton PRO can be used to assess mechanical properties (86). Nevertheless, this device has also other function such as: assessing tone or state of tension by measuring natural oscillation frequency, assessing biomechanical properties - dynamic stiffness and elasticity, and assessing viscoelastic properties - mechanical stress relaxation time and ratio of deformation and relaxation time. Myoton Pro is reliable not only for big muscles but also for small ones (88-90). The MyotonPRO device is capable of measuring five parameters related to muscle characteristics. Additionally, it can evaluate four indexes that pertain to biomechanical characteristics. These four indexes include Tone (natural oscillation frequency), Stiffness (dynamic stiffness), Elasticity (logarithmic decrement of natural oscillation), and Viscoelastic properties (creep and relaxation time).

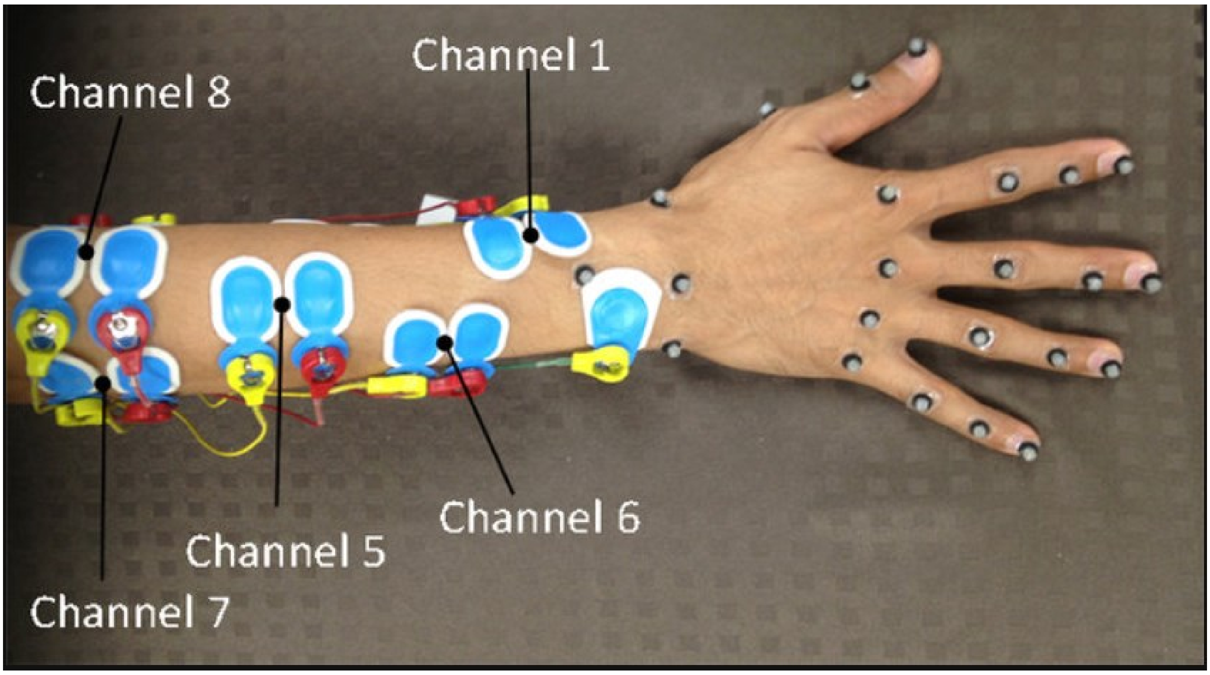
- Tone (Frequency in MyotonPRO) is the mechanical tension in a relaxed muscle, with increased tone indicating issues such as pain, athletic underachievement, and overload.
- Stiffness (Stiffness in MyotonPRO) measures a muscle's resistance to external forces and can impact athletic performance and movement rhythm.
- Elasticity (Decrement in MyotonPRO) refers to a muscle's ability to restore its shape after deformation, affecting muscle fatigue and movement speed.
- Viscoelastic properties, including creep and relaxation time, represent a muscle's recovery time after contraction or deformation (91).

Fig. 9 MyotonPro (source: https://www.healthlinkholdings.com/products/measurement-assessment/digital-palpation-device-myotonpro/)

2.5.3.3. Electromyography (EMG)

Surface electromyography (Fig. 10) studies are showing that the muscles which are having some trigger points are initially fatigue, getting tired faster and become more exhausted earlier than normal muscles (Giamberardino, Affaitati, Fabrizio, & Costantini, 2011). Therefore, after releasing trigger point with using myofascial release techniques muscle should have same respond as other healthy muscle.

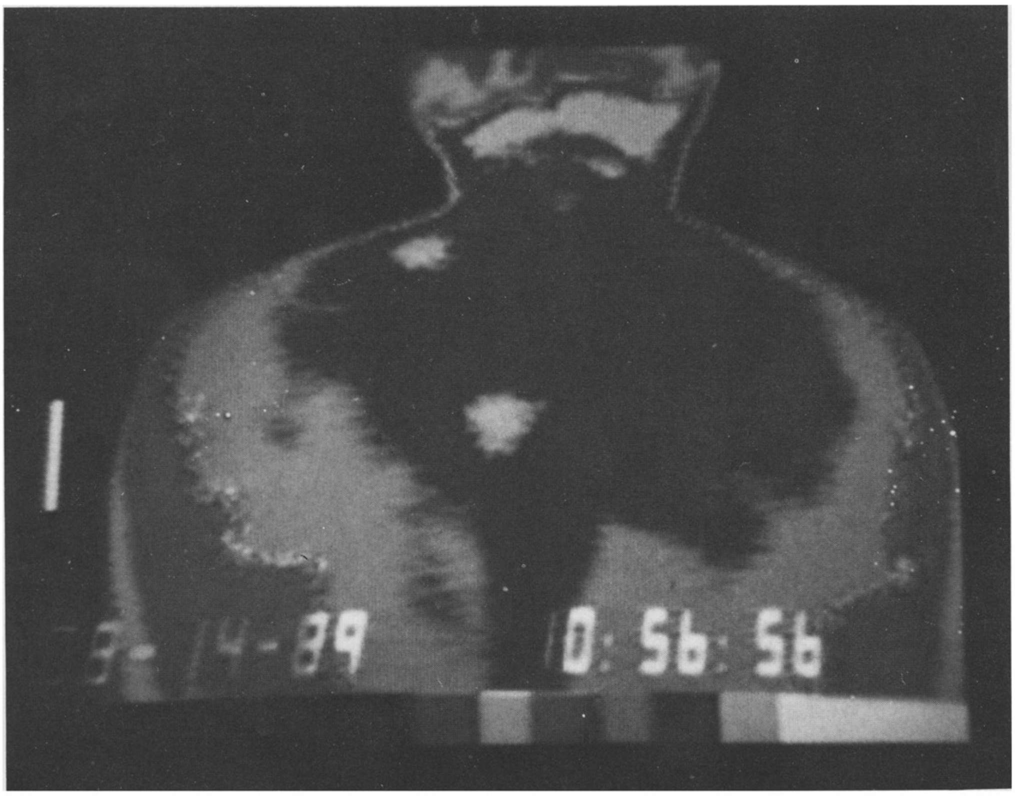
Fig. 10 surface EMG (source:(92))



2.5.3.4. Thermography

Thermography (Fig. 11) is a non-invasive method which enables measuring temperature distribution in human body (93). It can be either contact or contactless measurement depending on used device. However, in assessing trigger points is more convenient to use contactless. Thermography is creating map of radiation of the body; nevertheless, microwave radiometry can penetrate to subcutaneous tissue depth (1-2 cm) (94). In healthy body, temperature is symmetric on both sides. It had been proven that trigger points occurring on myofascial are increasing temperature (95). Unfortunately, thermography is not exclusively diagnosing underlying trigger points because it also shows other conditions as radiculopathy etc. are also increasing temperature. As a conclusion it can be used as first step in diagnostic of trigger points but has to be supported with other method to confirm diagnose (96, 97).

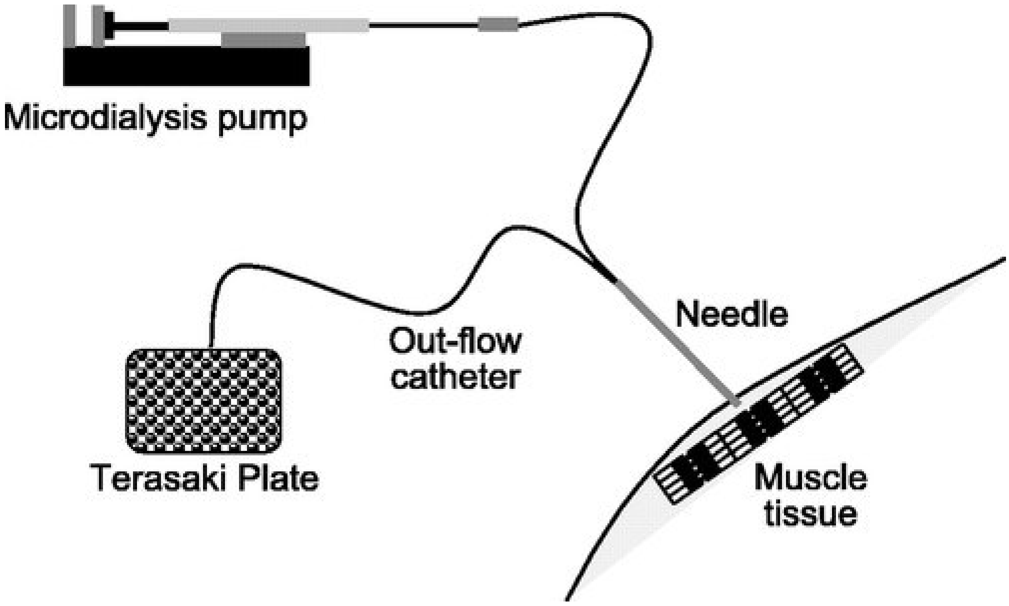
Fig. 11 Thermogram of subject, which presents trigger points (98).



2.5.3.5. Microdialysis

Microdialysis is a minimally-invasive sampling technique that is used to measure chemical composition of interstitial fluid by means of a semi-permeable membrane at the tip of a probe (Fig. 12). Microdialysis enables in vivo sampling and measurement of tissue chemistry, and this technique has been applied to studies of human muscle, blood, adipose tissue, ocular tissues, brain, and liver. Its use is feasible in virtually every human (99, 100). It has been shown that pro-nociceptive substances, such as bradykinin, substance P, protons, calcitonin gene-related peptide, tumour necrosis factor-alpha, interleukin-1beta, serotonin and norepinephrine are appearing in higher amount in the trigger points spots. This method is very effective for research purposes but unfortunately not for clinic usage.

Fig. 12 Schematic of perfusion pump and collection plate (99).



2.5.4. Patient perception

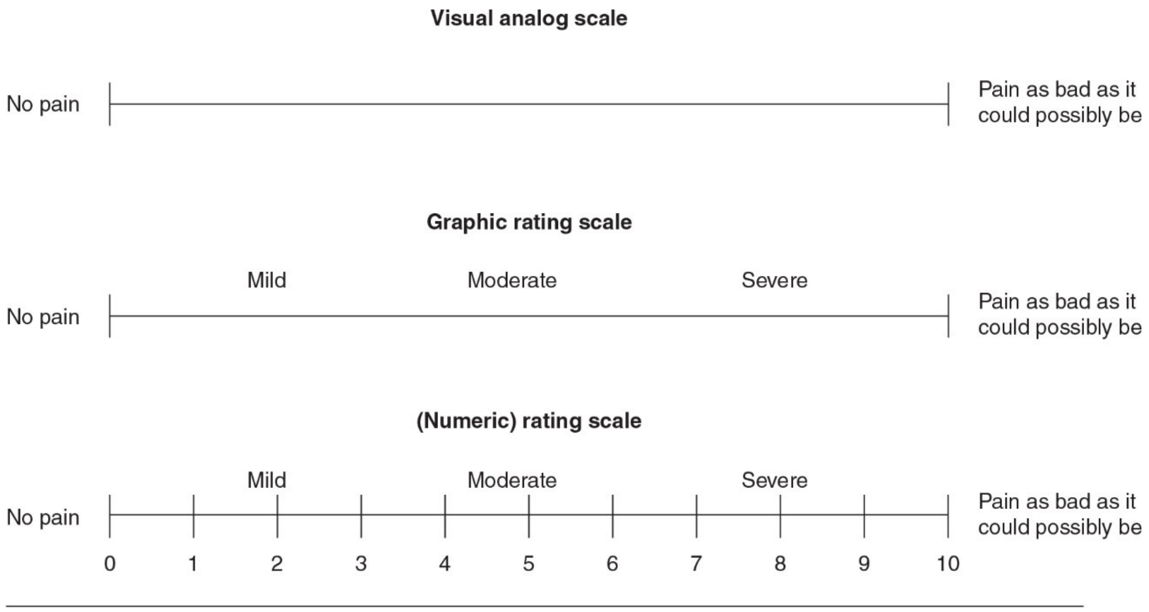
Pain is affecting every part of life from range of motion, perception of extremity to depression led through constant pain. Thus, there are many scales to use for achieving results of myofascial release therapy, can be used either simple scale VAS or quality of life scale. Here will be described just main one: Visual analogue scale -VAS.

2.5.4.1. Scale VAS

Visual analogue scale (VAS) scale is the mostly commonly used scale to describe pain (Fig. 13). Most probably it gained the popularity by its simplicity and reliability. However, it is just subjective patient opinion about the pain, and different people has different pain threshold which makes it difficult to compare between people. Also, there are many other things affecting perceiving the pain, as period cycle in woman or other hormone disbalances. Although it is good scale to assess the results of the treatment.

Scale basically contain line, sometimes it looks like ruler with numbers from 0 to 10. Patient is showing by finger or telling number how much pain he currently feels. Line can be horizontal or vertical. There are many variation of the test (101).

Fig. 13 Example of VAS (Source: https://epos.myesr.org/posterimage/esr/ecr2019/147589/mediagallery/831415?deliveroriginal=1)



2.6. Muscle stiffness

2.6.1. Muscle stiffness description

Muscular stiffness is defined as the ratio of change in force to the corresponding change in length when the length change is caused by an external agent or a change in the external load on the muscle. In the context of this discussion, stiffness is dynamic and varies over time, as it is influenced by the dynamic properties of the muscle. Traditionally, stiffness was used to describe the static and elastic component of impedance. However, due to the nonlinear properties of muscles, it is not easy to partition muscular impedance into components corresponding to derivatives of position. Nevertheless, in motor systems research, the term "stiffness" is still used to describe the resistance of muscle to length change (102). Particularly lower extremity stiffness is recognized as a crucial attribute for improving performance in activities such as running, jumping, and hopping, which are commonly found in various sports (103).

2.6.1.1. Stiffness of Inactive Muscle

The stiffness of inactive skeletal muscle is primarily determined by the elastic properties of connective tissue that is arranged in parallel and in series with the muscle fibers. This stiffness tends to increase at longer muscle lengths, which can limit extreme joint angles and provide stability. However, within the physiological range of muscle length, this stiffness is typically low and does not significantly resist joint motion. Nonetheless, even inactive muscle can offer some resistance to small disturbances.

Studies have shown that some cross-bridges, which are responsible for muscle contraction, may remain attached to the muscle fibers even when the muscle is at rest, working slowly or not at all. These attached cross-bridges can contribute to additional stiffness in the muscle. However, this additional stiffness can be reduced by stretching the muscle beyond the range of cross-bridge activity or by prior activation of the muscle. These non-cycling cross-bridges can reattach and increase stiffness again over a period of seconds, a phenomenon known as "thixotropic" properties of inactive muscle. This has been observed in experiments on animals and human subjects, and may play a role in maintaining steady postures (104).

2.6.1.2. Stiffness of Active Muscle

When a muscle is activated, it becomes considerably stiffer as the joint angles change within the normal range of motion. The magnitude of this stiffness, which is a property of the muscle itself, depends on various factors, including the level of motor unit recruitment, muscle length, muscle force, and movement history. It is believed that the mechanical properties of cycling cross-bridges within the muscle contribute to this stiffness, as cross-bridges have spring-like characteristics when attached. The stiffness of a muscle fiber with cycling cross-bridges depends on the average number of cross-bridges attached and the rate at which they turn over. The contribution of a particular cross-bridge to the stiffness of the muscle fiber increases with the length change that occurs while it is attached and decreases with a higher rate of turnover for a given rate of stretch. These basic principles can explain how muscular stiffness changes under different contractile conditions and how it is influenced by the composition of muscle fiber types.

If a muscle fiber, after a period of isometric contraction where it does not change in length, is then stretched by a small amount, within the range where the attached cross-bridges can still function, the muscle fiber exhibits spring-like behaviour known as short-range stiffness. However, if the stretch takes the muscle fiber beyond the range where the cross-bridges can effectively contribute to stiffness, then the stiffness abruptly declines as the cross-bridges are mechanically disrupted (105).

The extent of decline, or yield, and short-range stiffness of a muscle depend on the rate at which it is stretched and the rate of turnover of cross-bridges. Increasing the rate of stretch can result in increased short-range stiffness, as the cross-bridges remain attached over a larger range of length change (106). It can also increase yield, as more cross-bridges detach synchronously and reattach faster relative to the rate of stretch. On the other hand, an increase in the rate of turnover of cross-bridges would lead to a slight decrease in stiffness, as cross-bridges remain attached for shorter durations, and a decrease in yield due to more rapid reattachment. Therefore, when a previously isometrically contracted muscle is forcibly lengthened, it initially exhibits short-range stiffness followed by yield, which can result in a transient reduction in force. This behaviour can be summarized as active muscle showing significant, albeit nonlinear, damping, which can stabilize the musculoskeletal system (107). If the muscle is allowed to shorten instead, the force declines throughout the shortening, but the stiffness is greater over the short range compared to lengthening (108).

If the muscle fiber is perturbed after a period of motion, its mechanical properties are different from those described above. Constant motion leads to increased turnover of cross-bridges and a tendency for cross-bridges to be in positions of lower stress compared to the isometric state. As a result, the yield decreases and the short range is extended, making the muscle responses to length change more similar to those of linear springs with some damping (109). During quiet standing, stability is achieved in part by intrinsic mechanical properties of muscles, including the thixotropic properties of inactive muscles and the short-range stiffness and damping of active muscles. However, during ongoing movements, muscular stiffness is less dependent on the amplitude of perturbations, and the thixotropy in inactive muscles is greatly reduced to accommodate a wide dynamic range of joint motion.

2.6.2. Process Regulation

The mechanical properties of muscles are locally regulated by reflex circuits in the spinal cord. When a muscle is mechanically perturbed, its initial response and that of the musculoskeletal system depend on its intrinsic mechanical properties. However, after a brief delay, feedback from muscle spindle receptors can modify the recruitment of motor units and firing rate modulation in response to muscle lengthening or shortening, through the monosynaptic reflex. Muscle spindle receptors, which contain specialized intrafusal muscle fibers, signal changes in muscle length and the dynamics of length change. The monosynaptic reflex can recruit significant numbers of motor units even at low forces, due to the high sensitivity of the primary receptors of the muscle spindle, making the stiffness of the muscle-reflex system less dependent on background force compared to intrinsic muscular stiffness. However, since stiffness remains somewhat force-dependent, co-contraction of muscles can still result in increased joint stiffness (102). Similar to extrafusal muscle fibers, the length signals from intrafusal muscle fibers are subject to history-dependent properties due to their filtering properties (110). The monosynaptic reflex compensates for muscular yield through the recruitment of additional motor units, but this compensation is reduced during ongoing motion when the yield is less (109). This way, the stretch reflex can regulate muscular stiffness over a wide range of forces and movement histories, reducing the computational burden on the central nervous system.

2.6.3. Function of muscular stiffness

The initial response of a muscle to changes in length is primarily determined by its intrinsic stiffness. However, reflex pathways come into play after a brief delay to further regulate the response. Both intrinsic and extrinsic mechanisms work together to regulate the mechanical properties of joints in three-dimensional ways, depending on the attachments of the muscles that cross the joint. The stiffness of synergistic and antagonistic muscles adds up to determine the overall stiffness of the joint for a given axis or rotation. Muscular stiffness has an impact on interjoint coordination, not only through regulation of individual joints, but also through mechanical coupling of multi-articular muscles. These intrinsic and extrinsic mechanisms collectively influence the endpoint stiffness of the limb and coordination of the component joints (102, 111). Therefore, muscle stiffness can be considered a factor that influences the energy exchange between muscles, tendons, and ligaments (112, 113).

The stiffness of the legs and joints is influenced by various parameters, making it challenging to control during complex activities. Studies have shown that leg stiffness can be influenced by factors such as stride frequency during running (114) or hopping frequency during bouncing in place time (115, 116). Additionally, it has been shown that stretch-shortening cycle exercises lead to acute reduction in joint stiffness (117).

2.6.4. Pathology

The growth and maintenance of muscles are significantly influenced by the load and length they experience (118). In conditions where muscles are subjected to prolonged shortening, such as in spastic diplegia, the muscle fibers may become shortened, resulting in a characteristic equine (toe-walking) posture. Additionally, the tendons may account for a larger proportion of the total muscle length. As a result, the shortened muscle fibers may exhibit reduced shortening velocity, increased active stiffness, and overall increased stiffness (119-122). Furthermore, increased muscle stiffness, along with its clinical counterpart static flexibility, have been identified as risk factors that may exacerbate symptoms of muscle damage following eccentric exercise (123).

2.6.5. Lower extremity stiffness and its effect on jump performance

There are various classifications and calculations of lower extremity stiffness, including joint stiffness (K_{joint}), vertical stiffness (K_{vert}), and leg stiffness (K_{leg}), as well as muscle and tendon stiffness. These different parameters and terms are outlined in Table 1. K_{vert} is often considered the standard gauge for stiffness and serves as the basis for models of K_{leg} and K_{joint} (124-126). K_{vert} is commonly used to assess jumping and hopping tasks, while K_{leg} is more suitable for measuring walking and running tasks, as it allows for the measurement of leg length changes with each stride. Additionally, K_{joint} is a fundamental measure that impacts both K_{vert} and Kleg, as the stiffness response at the joints involved affects the overall stiffness of the lower extremity.

Table 1. Classifications and definitions of lower extremity stiffness (Source: (103)).

Classification of stiffness	Definition	Appropriate term
K_{joint}	The resistance to change in angular displacement for flexion and rotation after implementation of joint moments	Joint stiffness
K_{vert}	The sum of resistance of the human body to vertical displacement after utilization of ground reaction forces	Vertical stiffness
K_{leg}	The resistance to change in leg length after utilization of internal or external forces	Leg stiffness

Kubo et al. (127) conducted a study revealing that the elastic properties of tendon structures contribute to enhanced vertical jump performance, particularly when utilizing a countermovement. Furthermore, Anderson and Pandy (128) observed significant differences in electromyographic activities and greater forces developed by the quadriceps femoris and hamstrings during countermovement jumps (CMJ) compared to squat jumps (SJ). They concluded that although an increase in muscle force in the proximal extensors did not significantly increase the amount of elastic energy stored during CMJ due to relatively short and stiff tendons in the proximal muscles, the results from Kubo indicated that the tendon structures of the vastus lateralis (VL) exhibited considerable compliance. Consequently, the elastic energy stored in the tendon structures of VL likely contributed to the jump performance during CMJ. Therefore, to evaluate jump performance CMJ was used and for dynamic stiffness measurement, it was determined that the VL, rectus femoris (RF), and biceps femoris (BF) muscles would be considered.

Because the stretch-shortening cycle is strongly related to fitness (129), higher stiffness appears to be beneficial for athletic performance (130-132). However, there is evidence indicating that excessive stiffness may be associated with a higher risk of injury (125, 133, 134).

Both FR and tissue flossing techniques are anticipated to reduce muscle stiffness without negatively impacting sports performance (33, 135). Consequently, these methods are expected to have a positive influence on performance by decreasing muscle stiffness and increasing ROM.

2.6.6. Dynamic stability

The Y-Balance test (YBT) was developed as a time-efficient assessment to evaluate dynamic limits of stability and asymmetrical balance in three specific directions: anterior, posteromedial, and posterolateral. It is based on the research conducted on the Star Excursion Balance Test™ but focuses on a shorter test protocol. Interrater test-retest reliability of the YBT has been shown to be good, with an acceptable level of measurement error when used by multiple raters to screen active duty service members (136). Consequently, it has become a reliable tool for assessing injury prevention. Plisky et al. (137) identified that individuals with anterior left/right asymmetries greater than 4 cm on the YBT were 2.5 times more likely to sustain a lower extremity injury. These findings were further supported by a study conducted by Smith et al. (138), which included 184 athletes. Additionally, Y-Balance test results appear to be influenced by muscle stiffness. A recent study by Hill et al. (139) found that individuals with lower VL stiffness and tone exhibited greater reach distances in a lower extremity reaching task, indicating enhanced neuromuscular performance.

Based on the aforementioned findings, it can be inferred that interventions targeting decreased muscle stiffness, such as FR and TF are likely to have a positive impact on reach distances in the Y-Balance Test among participants. By reducing muscle stiffness, these interventions may improve neuromuscular performance and dynamic stability, leading to increased reach distances and potentially reducing the risk of lower extremity injuries.

3. Hypothesis and aims of study

The primary objective of this study is to examine the impact of an innovative technique called tissue flossing, when applied to the thigh, on the jump performance of athletes whose sports involve jumping. Additionally, the study aims to evaluate how this technique affects viscoelastic properties of the muscle, dynamic balance, and ROM.

Another objective of this research is to compare tissue flossing with the commonly used self-myofascial release technique using a foam roller. The goal is to determine which method is more suitable for incorporating into athletes' warm-up routines, aiming to enhance performance and prepare for competition or practice.

Null hypothesis 1: Tissue flossing applied to the thigh will not affect jump performance, brakingRFD, and ROM.

Null hypothesis 2: Tissue flossing will not yield greater improvements in jump performance, ROM, dynamic stability, viscoelastic properties of the muscle, and brakingRFD compared to foam rolling.

Null hypothesis 3: Both the foam rolling and tissue flossing conditionings will not demonstrate significant improvements when compared to the control conditioning.

Alternative hypothesis 1: Tissue flossing applied to the thigh will improve jump performance, brakingRFD, and ROM.

Alternative hypothesis 2: Tissue flossing will yield greater improvements in jump performance, ROM, dynamic stability, viscoelastic properties of the muscle, and brakingRFD compared to foam rolling.

Alternative hypothesis 3: Both the foam rolling and tissue flossing conditionings will demonstrate significant improvements when compared to the control conditioning.

The hypotheses were based on previous studies indicating the improvement of ROM, RFD and knee exertion after thigh application of tissue flossing (38, 140). However, most of them target only one limb or target different joint (140-142). As there is research which compares effect of tissue flossing and foam rolling on Triceps Surae, which indicates significant decrease in Achilles tendon stiffness and CMJ performance after tissue flossing application (33) such a comparison is missing for other parts of the body. Since quadriceps and hamstring muscles have significant impact on jump performance (143, 144) there is a reason to conclude that this improvement should occur also after tissue application.

Furthermore, according to a study conducted by Jones et al. (55) it was suggested that tissue flossing could potentially yield similar benefits to BFR training. Therefore, it is reasonable to speculate that, like BFR, tissue flossing may enhance jump performance when applied during lunges exercises, as indicated by Doma et al. in 2020 (145).

4. Experimental methods

4.1. Subjects

The research sample used in this study consisted of 30 healthy handball players (30 men) with 8-10 years of experience in handball, from Dukla Sport Club in Prague. Subjects were aged from 15-18 years old (Table 2), practicing handball on high level, with practices 4 times per week. 29 participants indicated right as dominant leg only one had left as dominant leg. Subjects were recruited on the basis that they were healthy, injury-free for at least 3 months. Participants were given clear instructions not to engage in lower body resistance exercises for a period of 24 hours prior to the testing to prevent fatigue. They were advised to maintain their regular dietary and sleep routines. Participants had the freedom to withdraw from the experiment at any point and were fully informed about the advantages and potential risks associated with their participation before giving their written consent. The expected results of the study were not disclosed to the participants. The research was approved by the UK FTVS Ethics Committee under number 177/2020 (Annex 1).

Table 2. Descriptive statistic of subjects. SD- standard deviation, Min- minimal value, Max- maximum value, BF -Body Fat.

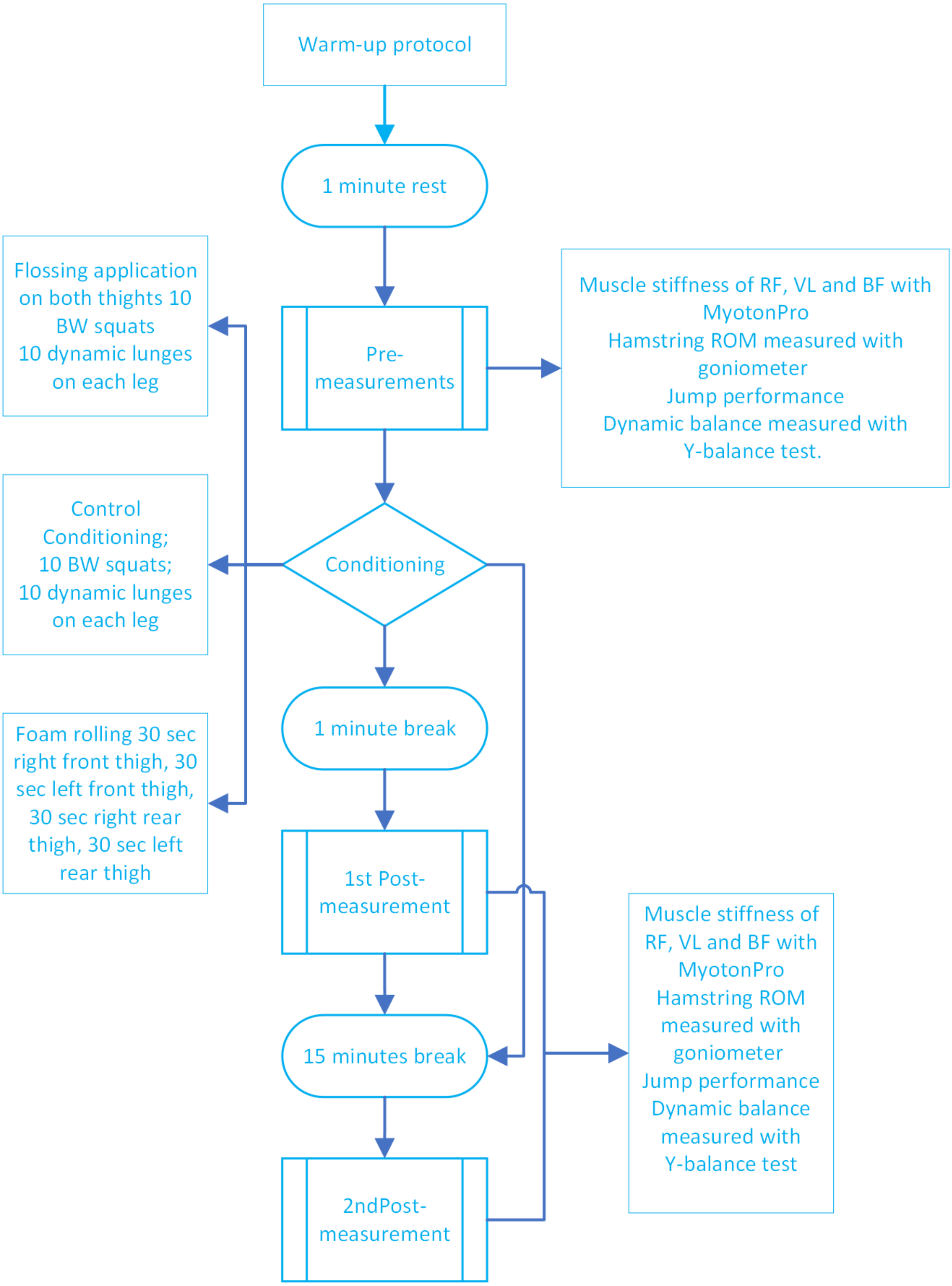
Variable	Mean	SD	Min	Max
Age (y)	16.67	0.52	15.98	17.68
Height (cm)	180.59	8.45	169.00	197.00
Weight (kg)	72.92	10.92	49.10	94.10
BF %	15.59	3.50	9.10	25.40
Muscle mass (kg)	58.17	7.05	42.30	70.40
L leg lenght (cm)	97.47	4.91	89.40	106.40
R leg lenght (cm)	97.24	5.06	88.30	105.90

4.2. Experimental procedures

Before beginning the measurements, the participants were randomly assigned to the protocols in a randomized order. Each participant completed all of the protocols, experiencing each one in a predetermined sequence unknown to the participants. At the beginning of the first session, the subjects underwent a familiarization process with the protocol. A certified physiotherapist then measured the leg length, and markers were placed on the body for VL (vastus lateralis), BF (biceps femoris), and RF (rectus femoris) muscles on both legs, following the guidelines provided by SENIAM. The participants were instructed to keep the markers placed on their bodies throughout the entire measurement period and to correct them after each shower. Following the placement of markers, the subjects underwent body composition measurements using a TANITA device from Japan (Fig. 14). The subjects were kept blinded and did not have access to information regarding which specific protocol would be performed. Additionally, the subjects were instructed to refrain from engaging in any lower limb exercises for 24 hours prior to each session. The measurements were conducted over a period of 2 weeks, with at least a 24-hour and maximum 5 days break between each measurement for the participants.

The measurements were conducted in the Training Adaptation Laboratory, located in the Faculty of Physical Education and Sport at Charles University. Throughout the entire measurement period, the room temperature was recorded three times a day: at the beginning, middle, and end of the measurements. Most of the time, the temperature in the room fluctuated around 22 degrees Celsius, with two instances where it reached 25 degrees Celsius. Unfortunately, the researcher was unable to affect the temperature due to the absence of air conditioning in the laboratory. The humidity level in the room was maintained at approximately 50-60%.

Fig. 14 Graphical representation of the basic measurement design (Source: private).



Protocol included 3 conditioning: FR- foam rolling, TF- Tissue flossing and CON- control. All conditionings lasted same amount of time: approximately two minutes.

Before each measurement, the subjects followed a standardized warm-up routine. This warm-up consisted of the following steps:

- Five minutes of cycling on a cycloergometer at 100W with an 80 rpm.
- Ten bodyweight squats.
- Dynamic stretching of the quadriceps with 10 repetitions on each leg.
- Dynamic stretching of the hamstrings with 10 repetitions on each leg.
- Leg swings with 10 repetitions on each leg.
- Lunge dynamic stretches with 10 repetitions on each leg.
- Five bodyweight squats.
- Five bodyweight jumps at 75% of maximum effort.

These standardized warm-up exercises were performed by the subjects before each measurement session. After a one minute rest period, Myoton measurements were taken. The measurements began with the subject lying in a prone position with a roller placed under the knees for the measurement of the RF and VL muscles on the right leg. Then, the RF and VL muscles on the left leg were measured. Subsequently, the subject was rotated to a supine position with a roller placed under the ankles, and the measurement of the BF (biceps femoris) muscle was initiated, starting from the right leg, and concluding on the left BF muscle. Following the Myoton measurements, the participants had active knee extension angle evaluated. Subjects laid prone on the table and flexed their knee and hip to 90°. During the test, the subjects manually monitored the position of their femur and ensured it remained at a 90° flexion angle throughout. They then straightened their right leg to its maximum extent while keeping the foot relaxed. This position was held for a duration of 5 seconds. A standard SAEHAN goniometer was placed over the pre-marked lateral joint axis, with its arms aligned along the femur and fibula. The knee joint angle was then measured and recorded in degrees using the goniometer. The angle measurement was calculated by subtracting the recorded knee joint angle from 90 degrees. This calculation was performed to determine the amount of knee extension in degrees from the 90-degree reference point. This method is considered as a reliable method of hamstring muscle length (146). Firstly, the measurement was performed on the right leg, and then the same procedure was repeated on the left leg. Then participants proceeded to the force plates (Hawking Dynamics). They were instructed to perform three Countermovement Jumps (CMJ) with their hands on their sides. The rest period between each jump was 15 seconds. The subjects were specifically instructed to exert maximum effort in order to achieve the highest possible jump height. Verbal motivation was provided by the researchers throughout the jumping protocol. After completing the jumps, the subjects proceeded to the Y Balance Test. They removed their shoes and began the measurement by standing on their left leg with their hands at their sides. They then moved into the anterior direction, followed by the posteromedial and posterolateral sides. Once they successfully completed three attempts of each direction on the left leg, they switched to standing on their right leg and repeated the test. Maximum value of each side was taken for the calculations. The participants were already familiar with the Y Balance Test, as it was included in their warm-up routine under the guidance of the head coach.

The intervention initiated right after premeasurements. On three different occasions participants underwent either tissue flossing (TF), foam rolling (FR) or control (CON) conditioning. The post-measurements were conducted in the following order: starting from the 2nd minute after the intervention, and then starting from the 15th minute after the intervention. The same order as the pre-measurements was maintained, beginning with the assessment of muscle stiffness using MyotonPro on the RF, VL, and BF muscles, followed by the measurement of active knee extension angle. Subsequently, jump performance was evaluated, and finally, dynamic stabilization was assessed. Participants were instructed to engage in walking during the rest period between the warm-up and intervention, as well as between the intervention and post-measurements. Similarly, during the intervals between post-measurements, participants were asked to continue walking.

4.3. Practical procedures

4.3.1. Tissue Flossing intervention (TF)

Participant seated on the edge of the table with legs resting on chairs with knees slightly bended. Tissue flossing was performed using green Sanctband Comprefloss band 5 cm x 3,5 m by two trained therapists with previous experience in tissue flossing methods. The floss band was wrapped around the area just above the distal third between the anterior superior iliac spine (ASIS) and patella, serving as an anchor point as suggested in other study (140). With maintained tension, the band was stretched to 1.5 times its natural length. The researcher then proceeded to wrap the thigh from distal to proximal, ensuring a 50% overlap with each subsequent wrapping of the band over the previous part. Both legs were wrapped simultaneously, with monitoring of the pressure using Kikuhime pressure sensor.

Once the floss was applied, the participants performed 10 bodyweight squats, ensuring that they reached a 90-degree knee flexion angle. The squats were performed with a specific tempo of 2 seconds for the eccentric phase, 1 second at the bottom position, 2 seconds for the concentric phase, and 1 second at the top position in accordance with a metronome. After completing the squats, the participants proceeded to perform 10 dynamic lunges on each leg, alternating between legs. Once the exercises were completed, the tissue band was removed, and the participants were instructed to walk. The entire application procedure took approximately 2 minutes to complete.

4.3.2. Foam rolling application

The participants were instructed to position their lower limb in the designated position and place as much of their body weight as possible onto the foam roller. They were then instructed to move back and forth on the foam roller in the same area where the tissue flossing was applied, specifically the distal third between the ASIS and patella. For the anterior thighs, the participants assumed a plank position. The treated leg was placed on the foam roller device, while the foot of the non-treated leg remained off the ground. In the case of the hamstrings, the participants sat on the floor with the foam roller positioned under their hamstrings. They placed their hands on the ground to the side and kept their feet in the air. Each quadriceps (staring from right and then left) was rolled for 30 seconds, followed by the hamstrings firstly on the right and left side, also for 30 seconds each. The duration of 30 seconds was chosen because it is similar to the total time of tissue flossing application, and previous studies have shown that it is sufficient to produce positive results in terms of hip range of motion and jump performance (147-149).

4.3.3. Control condition

In the control conditioning, the participants followed a protocol similar to Tissue Flossing, but with one key difference: their thighs were not flossed with a band. The participants began by warming up and then performed 10 bodyweight squats, ensuring that they reached a 90-degree angle at the knee flexion. These squats were executed with a specific tempo: 2 seconds for the eccentric phase, 1 second at the bottom position, 2 seconds for the concentric phase, and 1 second at the top position, all guided by a metronome. Once the squats were completed, the participants proceeded to perform 10 dynamic lunges on each leg, alternating between legs.

5. Data collection

Collection of the data started in this measurement from pre measurement which started one minute after warm up. Data was collected always in the same order starting from Myoton measurements, then proceeding to active knee extension, evaluating jump performance on force plates and dynamic stability on Y-balance test.

5.1. MyotonPro measurements

The handheld myometer (MyotonPRO, Myoton AS, Tallinn, Estonia) was utilized to assess the viscoelastic muscle properties of the Rectus RF, VL and BF muscles in both limbs. This assessment was performed noninvasively by applying superficial mechanical deformation using the device's probe, which was positioned perpendicular to the skin. A brief mechanical compression of 0.4 N for 15 milliseconds was applied, along with a constant preload force of 0.18 N. Following the mechanical impulse, the soft tissue of the muscles exhibited a damped oscillation response, which was measured using an accelerometer (150). Points of measurements muscle viscoelastic properties were measured with measurement tape before measurements and mark with marker. For VL and RF proband laid in prone position on the table with the knees in slight flexion. The RF was measured at 50% on the line from the anterior spina iliaca superior to the superior part of the patella. Measurement for VL was at 50% of the straight-line distance between the greater trochanter and fibulae capitulum (150). For BF probands were laying supine with ankles resting on roller and in slight lateral rotation with respect to the thigh. BF was measured at 50% on the line between the ischial tuberosity and the lateral epicondyle of the tibia. Measurements were made in a state of muscle relaxation. All markers were measured by a certified physiotherapist, and the same individual applied the markers to the bodies of all participants. The following viscoelastic muscle properties were evaluated: muscle tone (oscillation frequency) and stiffness.

5.2. Active knee extension (AKE) measurement

Active knee extension test has been considered a reliable method to evaluate hamstring length (146) therefore it has been chosen as a method to asses effect of FR and TF on hamstring flexibility. During the initial session, a certified physiotherapist marked the centre of the knee joint axis on the lateral joint line of the right leg. From this axis point, two lines were drawn: one connecting the axis point to the centre of the greater trochanter of the femur, and another connecting the axis point to the apex of the lateral malleolus. Participants were instructed to keep these markers in place throughout the entire measurement period and to make any necessary corrections, such as after taking a shower.

For the measurement of active knee extension, the participants lay supine on a bench and flexed their right knee and hip to a 90° angle. They used their right hand to monitor the position of their femur and were instructed to prevent any movement of the femur away from their hand throughout the test. The participants were then instructed to extend their right leg as far as possible while keeping their foot relaxed, and to hold this position for 5 seconds. To familiarize themselves with the movement, each participant performed a single repetition. Subsequently, a second repetition was performed, and at the end of the 5-second holding period, the angle of knee extension was measured using a standard SAEHAN goniometer. The goniometer was positioned with its centre over the previously marked axis point on the lateral joint line, and the goniometer arms were aligned with the lines marked on the femur and fibula. The goniometer measurement was taken within 2 seconds of reaching the end range of knee extension, ensuring a consistent length of static stretch for each participant.

5.3. Jump performance measurement

Jumping assessments were conducted using a force plate (Hawkin Dynamics Inc., Maine, USA). Each participant performed three CMJs without utilizing arm swings. The subjects began in a standing position with their hands placed on their hips for this particular measurement. They then descended into a self-selected depth for the countermovement phase, followed immediately by a maximum effort vertical jump. The subjects were instructed to land in the same position as the take-off, specifically in the middle section of the force plate. After each jump, the subjects returned to the starting position, and the entire procedure was repeated for a total of three jumps. There was 15 seconds break between each of the jump. Moreover, each of the participant was verbally motivated by researchers to perform each jump as high as possible. The highest jump in terms of height was retained for further analysis.

5.4. Dynamic stabilization measurement

The Y Balance Test Kit™ is reliable method (136) and therefore was used to assess dynamic balance. Participants were instructed to maintain a single-leg stance using their dominant limb and to push a reach indicator along a pipe with their non-dominant limb. The reach directions (anterior, posteromedial, and posterolateral) (Fig. 15) were randomized. To minimize the influence of arm movements on postural control, participants were instructed to keep their arms by their sides (151). The test was repeated if any of the following criteria were not met: 1) failure to maintain single-leg stance (touching the floor with the reach limb), 2) failure to maintain contact with the reach indicator at the farthest point (kicking the reach indicator for extra distance), 3) using the reach indicator for weight support, 4) failure to return the reach foot to the centre of the foot plate, or 5) failure to keep the arms on the side.

For each reach direction, participants performed three trials, and the greatest reach distance achieved in each direction was used for further analysis. Limb length was measured using anthropometric measuring tape, from the anterior superior iliac spine to the most distal portion of the medial malleolus, and recorded in centimetres (152). The composite reach score (COMP) was calculated by summing the three reach distances and dividing the total by three times the limb length. The result was then multiplied by 100 (137).

Fig. 15 Y-balance test performed by one of the probands, respectively: L posteromedial, L anterior, R posterolateral (source: private).

6. Data Analysis

All data was analysed using SPSS (version 25.0; SPSS, Inc., Chicago, IL), organization of the date and graphs were created using MATLAB software. A Shapiro-Wilk test was used to test the normal distribution of the data, and Mauchly's test was used to test for the assumption of sphericity. If the p-value obtained from Mauchly's Test is below .05, it indicates a violation of the assumption. In such cases, the Greenhouse-Geisser correction is applied to address this violation. Two-way ANOVAs (3 X [FR; TF; CON] X 3 time points [pre, post1, post2] were used to investigate the influence of foam rolling and tissue flossing on viscoelastic muscle properties and dynamic stabilization and jumping performance. When a significant main effect or interaction was found, post hoc tests with Bonferroni correction were used to analyze the pairwise comparisons. The magnitude of mean differences was expressed with standardized effect sizes. The effect of the conditioning was calculated by Cohen's d effect size considering 0.2, 0,5, and 0,8 as small, medium, and large effect sizes, respectively (153). Thresholds for qualitative descriptors of partial eta square were interpreted as: $\eta 2 = 0.01$ a small effect, η2 = 0.06 a medium effect, η2 = 0.14 a large effect (154). Results are reported as the mean with standard deviations. Statistical significance was set at $p < 0.05$.

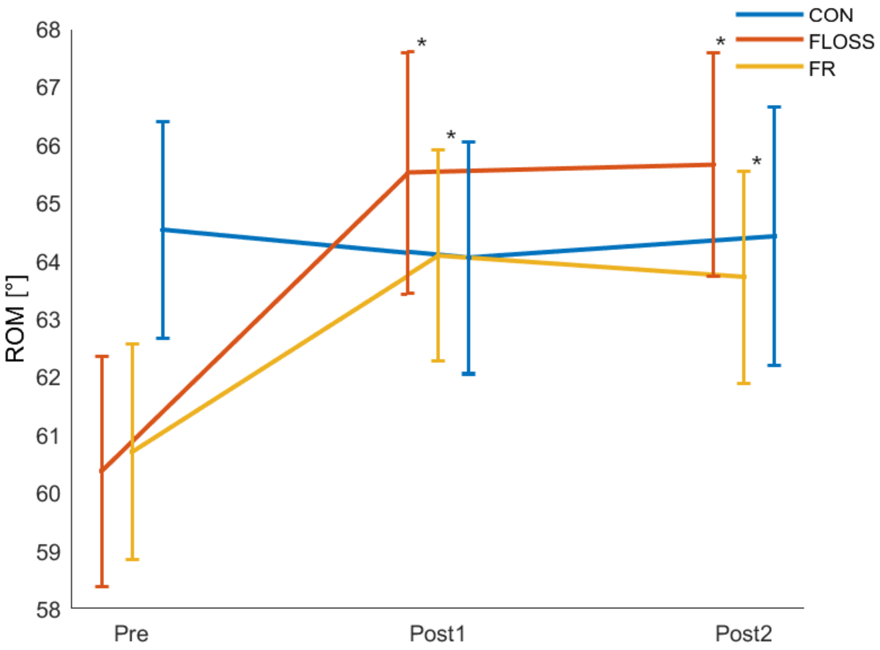
7. Results

The study involved a total of 30 participants, all of whom successfully completed the study. Certified physiotherapists conducted AROM analyses for all measurements and also assessed the viscoelastic properties.

7.1. ROM results

All conditionings for ROM rejected null hypotheses of normal distribution of the data, indicating that results are normally distributed. Two-way ANOVA indicated that there was statistically significant difference between pre and post measurements for right leg ($F_{(2,174)}=13.198$; $p < 0.001$; η2 = 0.132) and between the time of measurement and intervention ($F_{(4,174)} = 4.8$; $p < 0.002$; η2 = 0.099) with no differences between the interventions and control group ($F_{(2,87)} = 0.169$; $p = 0.845$; η2 = 0.004) (Fig. 16). Post hoc analysis revealed significant difference ROM improvement from pre to post1 and post2 measurement but not from post1 to post2. When compared pre and maximum post value no significant difference between all interventions ($F_{(2,87)} = 0.363$; $p = 0.697$). However, significant difference between pre and max post for tissue flossing and for foam rolling was found ($p < 0.001$). The effect size, as measured by Cohen's d, when compared pre and post max was for CON d = 0.31, FLOSS d = 1.21, FR d = 0.8.

Fig. 16 The mean ± standard error (SE) values for the range of motion (ROM) of the right leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning



For left leg repeated measures ANOVA shows statistically significant differences between pre and post measurements ($F_{(2,174)} = 12.452$; $p < 0.001$; $\eta 2 = 0.125$) and between the time and intervention protocol ($F_{(4,174)} = 6.178$; $p < 0.001$; $\eta 2 = 0.124$). However no significant interaction was found between the interventions ($F_{(2,87)} = 0.003$; $p = 0.997$; $\eta 2 = 0$). Post hoc analysis revealed significant difference ROM improvement from pre to post1 and post2 measurement but not from post1 to post2 (Fig. 17) (Fig. 18) (Table 3). Paired T-test revealed significant difference for pre and post1 and pre to post2 for tissue flossing conditioning ($p < 0.001$) for both left and right leg. For FR paired T-test showed significant improvement in ROM from pre to post1 for both left and right leg ($p < 0.001$, $p = 0.02$ respectively) and from pre to post2 for right leg ($p = 0.036$). No significant changes in control conditioning. Table 4 shows how many participants had positive, negative or did not respond to conditioning. When compare pre and maximum post values there was not observed significant difference between any of the interventions ($F_{(2,87)} = 0.101$; $p = 0.904$), however significant difference between pre and max post for tissue flossing and for foam rolling was found ($p < 0.001$). The effect size, as measured by Cohen’s d, when compared pre and post max was for CON d = 0.25, FLOSS d = 1.47, FR d = 0.95.

Fig. 17 The mean ± standard error (SE) values for the range of motion (ROM) of the left leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

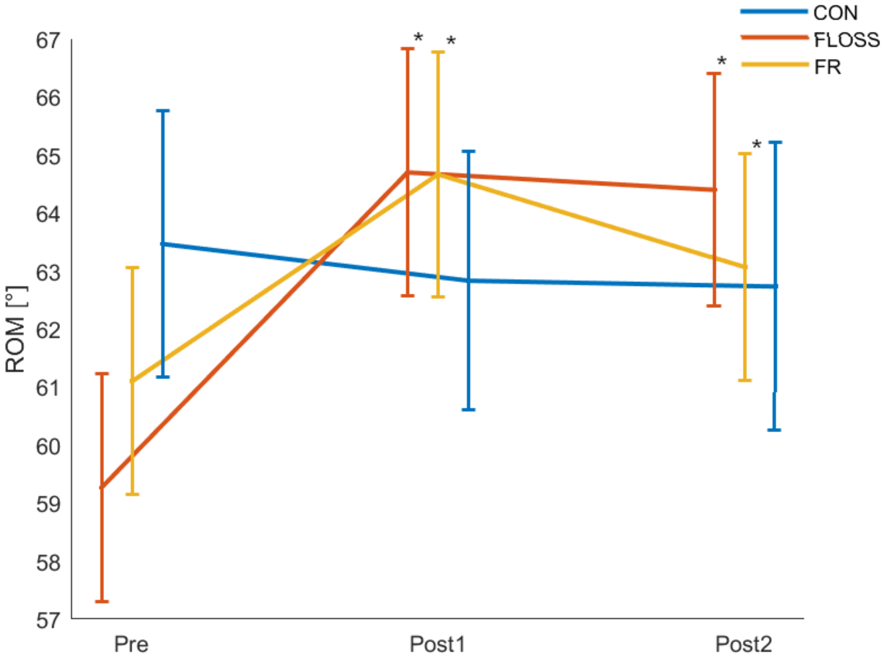


Fig. 18 Bar chart showing ROM results. pre -purple bar; green – post1, yellow – post2. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning, R right leg, L left leg

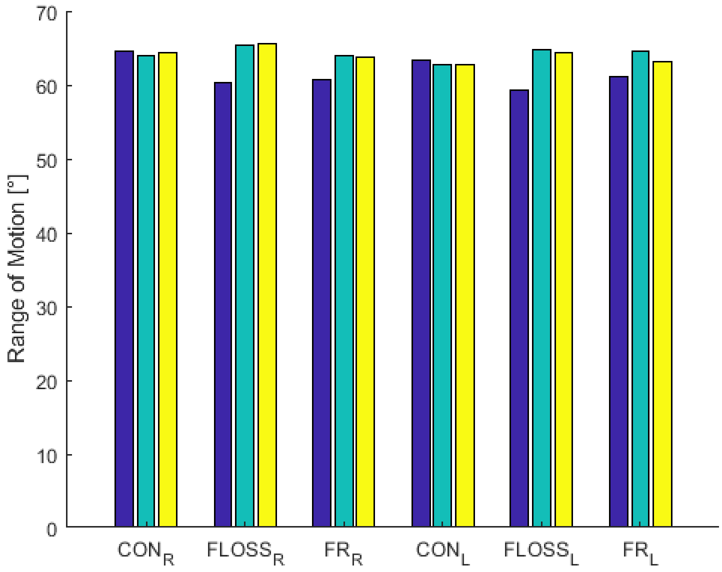


Table 3 The mean ± standard deviation (SD) values for the range of motion (ROM). CON- Control condition, FLOSS- tissue flossing condition, FR- foam rolling condition

Intervention	Side	Pre	Post1	Post2
CON	Right	64.53 ± 10.22	64.03 ± 10.88	64.4 ± 12.24
	Left	63.47 ± 12.56	62.83 ± 12.2	62.73 ± 13.59
FLOSS	Right	60.37 ± 10.9	65.5 ± 11.36	65.63 ± 10.58
	Left	59.27 ± 10.72	64.7 ± 11.7	64.4 ± 11
FR	Right	60.7 ± 10.19	64.07 ± 9.96	63.7 ± 10.01
	Left	61.1 ± 10.73	64.67 ± 11.54	63.07 ± 10.72

Table 4 Positive, negative and no-responses to the interventions for knee range of motion. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning.

Conditioning	ROM Right			ROM Left		
	Positive	Negative	No response	Positive	Negative	No response
CON	17	10	3	16	9	5
FR	23	7	0	23	5	2
FLOSS	28	1	1	28	1	1

7.2. Viscoelastic properties results

7.2.1. Vastus Lateralis (VL)

7.2.1.1. Left lower limb

The 2-way ANOVA indicated that there was no statistically significant difference between interventions on stiffness ($F_{(2,87)} = 0.5$; $p = 0.608$; $\eta2 = 0.011$) and muscle tone on the left leg ($F_{(2,87)} = 0.564$; $p = 0.571$; $\eta2 = 0.013$) . There were significant effects of interventions on time on: muscle tone ($F_{(4,174)} = 11.289$; $p < 0.001$; $\eta2 = 0.115$) and on stiffness ($F_{(4,174)} = 6.748$; $p < 0.001$; $\eta2 = 0.134$) and differences between pre and post measurements on muscle tone ($F_{(2.174)} = 4.559$; $p = 0.002$; $\eta2 = 0.095$) and on stiffness ($F_{(2.174)} = 15.509$; $p < 0.001$; $\eta2 = 0.151$). Post hoc analysis showed a significant decrease in muscle tone in all times of the measurement. Respectively from pre to post1, to post2 and from post1 to post2 ($p = 0.041$, $p < 0.001$, $p = 0.044$). For stiffness post hoc revealed significant difference between pre and post2, and post1 and post2 measurements ($p < 0.001$) no main difference occurred between pre and post1 ($p = 0.062$) (Fig. 19) (Fig. 20). Paired T-test revealed significant decline in muscle tone and muscle stiffness for FR from pre to post1 ($p < 0.001$) and from pre to post2 ($p = 0.001$, $p < 0.001$, respectively). The effect size, as measured by Cohen’s d, when compared pre and post max was for CON d = 0.15, FLOSS d = 0.52, FR d = 0.56 for muscle tone and CON d = 0.03, FLOSS d = 0.5, FR d = 0.76 for muscle stiffness.

Fig. 19 The mean ± standard error (SE) values for muscle tone [Hz] of the VL left leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

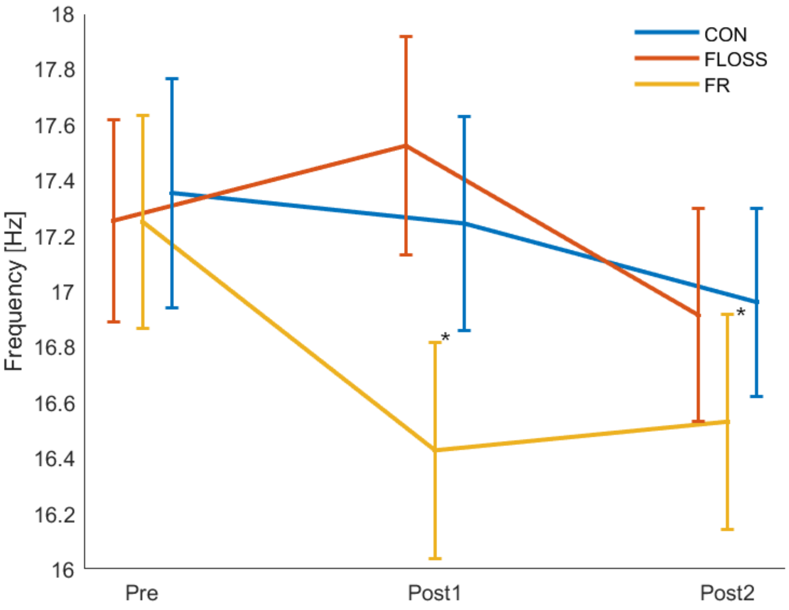
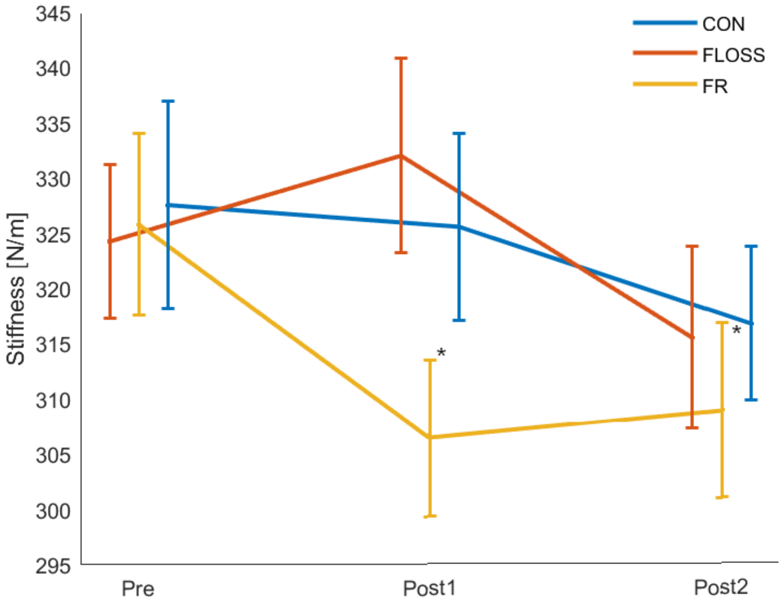


Fig. 20 The mean ± standard error (SE) values for stiffness [N/m] of the VL left leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning



7.2.1.2. Right Lower Limb

For VL on right lower limb repeated measures ANOVA shows statistically significant differences between pre and post measurements ($F_{(2,174)} = 16.897$; $p < 0.001$; η2 = 0.163) for muscle tone and for stiffness ($F_{(2,174)} = 36.366$; $p < 0.001$; η2 = 0.295). Main effect was observed of intervention on time ($F_{(4,174)} = 4.961$; $p = 0.001$; η2 = 0.102) for stiffness, however not in muscle tone ($F_{(2=4,174)} = 2.29$; $p = 0.67$; η2 = 0.05). Post hoc indicate main difference between pre and post2 measurements and post1 to post2 on both stiffness and muscle tone ($p < 0.001$), but no significant difference between pre and post1 in both measurements: muscle tone ($p = 0.184$) (Fig. 21) and stiffness ($p = 0.318$) (Fig. 22). For post1 measurements TF statistically significantly differed from FR ($p = 0.046$) where TF acutely increased stiffness (Mean difference 5.233). However, this increase in stiffness wasn't statistically significant ($p = 0.627$). Paired T-test shows significant difference for TF conditioning for muscle tone in stiffness in both from pre to post2 ($p = 0.005$, $p = 0.001$, respectively) and from post1 to post2 ($p < 0.001$). For FR T-test revealed significant difference in both: muscle tone and stiffness from pre to post1 ($p = 0.015$, $p < 0.001$, respectively) and pre to post2 ($p = 0.002$, $p < 0.001$, respectively). The effect size, as measured by Cohen's d, when compared pre and post max was for CON d = 0.03, FLOSS d = 0.23, FR d = 0.35 for muscle tone and CON d = 0.03, FLOSS d = 0.31, FR d = 0.59 for muscle stiffness.

Fig. 21 The mean ± standard error (SE) values for muscle tone [Hz] of the VL right leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

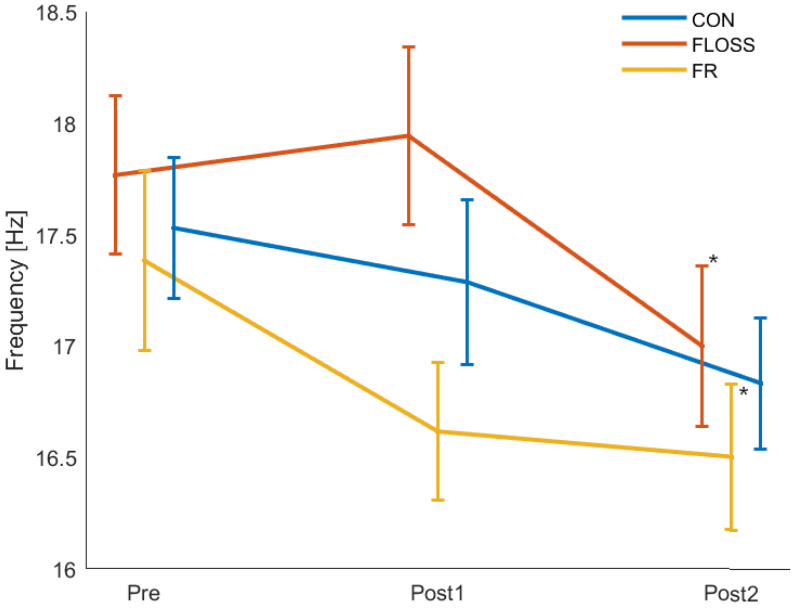
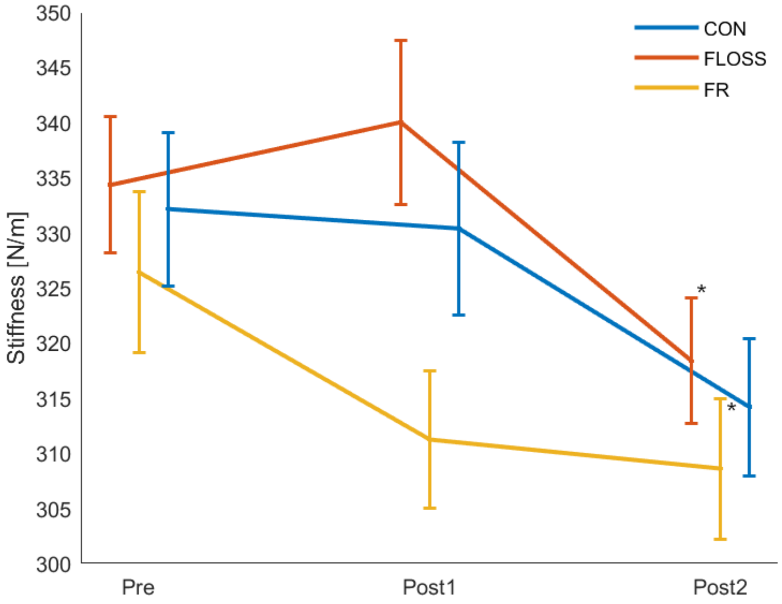


Fig. 22 The mean ± standard error (SE) values for stiffness [N/m] of the VL right leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning



7.2.2. Rectus Femoris (RF)

7.2.2.1. Left lower limb

The results of the 2-way ANOVA revealed that there were no significant differences between the interventions in terms of stiffness ($F_{(2,87)} = 0.845$; $p = 0.433$; $\eta2 = 0.019$) and muscle tone on the RF left leg ($F_{(2,87)} = 0.476$; $p = 0.623$; $\eta2 = 0.011$). However, significant effects of interventions were observed over time for muscle tone ($F_{(4,174)} = 3.863$; $p = 0.005$; $\eta2 = 0.082$) and for stiffness ($F_{(4,174)} = 7.693$; $p < 0.001$; $\eta2 = 0.15$). Additionally, there were significant differences between pre- and post-measurements in terms of muscle tone ($F_{(2,174)} = 6.589$; $p = 0.002$; $\eta2 = 0.07$) and stiffness ($F_{(2,174)} = 26.693$; $p < 0.001$; $\eta2 = 0.235$). Post hoc shows significant decline for frequency from pre to post2 measurement ($p = 0.003$) and for stiffness ($p < 0.001$) but no main differences between pre to post1 and post1 to post2 for both muscle tone ($p = 0.619$; $p = 0.061$) (Fig. 23) and stiffness ($p = 0.7$) (Fig. 24). For CON there was no statistically significant changes in muscle tone between the measurements. For FLOSS was significant drop in muscle tone from post1 to post2 ($p < 0.001$) whereas for FR were statistically significant changes from pre to post1 and post2 ($p = 0.19$, $p = 0.012$ respectively. Paired T-test shows significant decrease in muscle tone and stiffness for FR from pre to post1 ($p = 0.012$, $p < 0.001$, respectively) and from pre to post2 ($p = 0.004$, $p < 0.001$, respectively). For tissue flossing conditioning there was significant increase in muscle tone from pre to post1 ($p = 0.027$), however from post1 to post2 was significant drop in muscle tone ($p < 0.001$). For muscle stiffness no main effect on pre to post1 measurement was found, but significant drop from post1 to post2 and pre to post2 was found ($p < 0.001$, $p = 0.002$, respectively). The effect size, as measured by Cohen's d, when compared pre and post max was for CON $d = 0.14$, FLOSS $d = 0.51$, FR $d = 0.25$ for muscle tone and CON $d = 0.14$, FLOSS $d = 0.37$, FR $d = 0.71$ for muscle stiffness.

Fig. 23 The mean ± standard error (SE) values for muscle tone [Hz] of the RF left leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

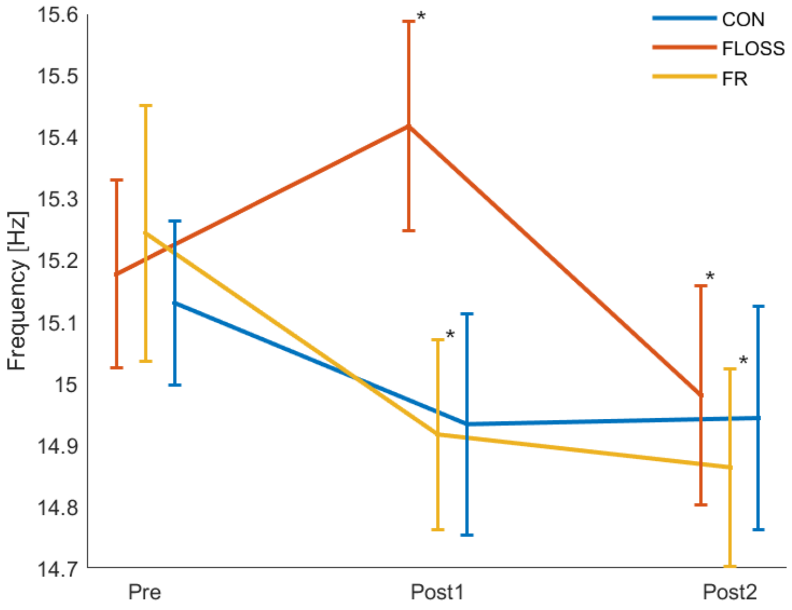
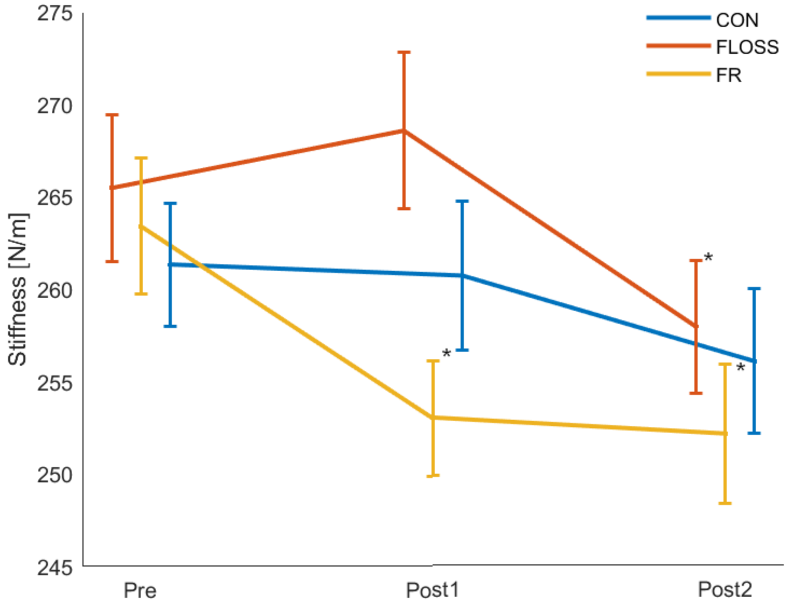


Fig. 24 The mean ± standard error (SE) values for stiffness [N/m] of the RF left leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning



7.2.2.2. Right lower limb

No statistically significant interaction was found between the interventions for tone in right leg for RF ($F_{(2,87)} = 0.363$; $p = 0.697$; η2 = 0.008) or stiffness ($F_{(2,87)} = 1.08$; $p = 0.344$; η2 = 0.024). Moreover, there were no statistically significant main effect of intervention and time for frequency ($F_{(4,174)} = 1.826$; $p = 0.126$; η2 = 0.04), yet there was a main effect of time in both: frequency and stiffness ($F_{(2,174)} = 23,691$; $p < 0.001$; η2 = 0.214 and $F_{(2,174)} = 30.238$; $p < 0.001$; η2 = 0.258 respectively). Additionally, there was significant main effect of intervention on time for stiffness ($F_{(4,174)} = 5.58$; $p < 0.001$; η2 = 0.114). The post hoc analysis showed a significant decline in frequency from pre to post2 measurement ($p < 0.001$) and for post1 to post 2 ($p < 0.001$) (Fig. 25), similarly for stiffness there is a significant decline from pre to post2 and from post1 to post2 ($p < 0.001$) but not from pre to post1 ($p = 0.344$) (Fig. 26) but no main differences between pre to post1 for muscle tone ($p = 0.194$). For TF paired T-test shows significant drop in muscle tone and stiffness from pre to post2 ($p = 0.001$, $p < 0.001$, respectively) and from post1 to post 2 ($p = 0.001$, $p < 0.001$, respectively). For FR paired T-test revealed significant decline in muscle tone and stiffness from pre to post1 ($p = 0.024$, $p = 0.006$, respectively) and pre to post2 ($p = 0.003$, $p < 0.001$, respectively). The effect size, as measured by Cohen's d, when compared pre and post max was for CON $d = 0.04$, FLOSS $d = 0.13$, FR $d = 0.24$ for muscle tone and CON $d = 0.13$, FLOSS $d = 0.5$, FR $d = 0.26$ for muscle stiffness.

Fig. 25 The mean ± standard error (SE) values for muscle tone [Hz] of the RF right leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

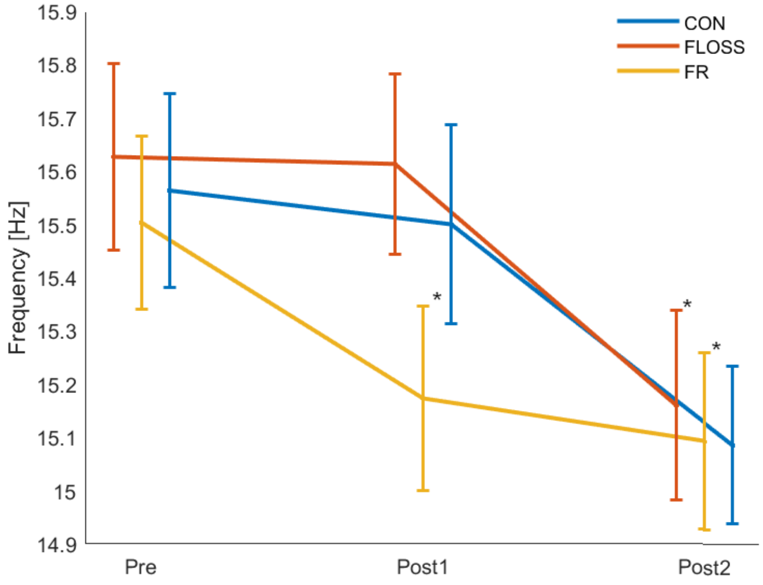
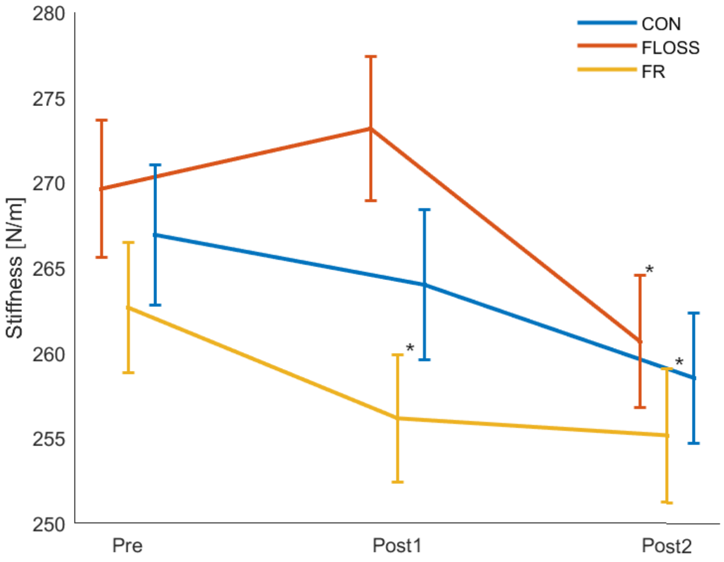


Fig. 26 The mean ± standard error (SE) values for stiffness [N/m] of the RF right leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning



7.2.3. Biceps Femoris (BF)

7.2.3.1. Left lower limb

No statistically significant interaction for muscle stiffness ($F_{(2,87)} = 0.234$; p = 0.792; η2 = 0.005) or tone ($F_{(2,87)} = 0.153$; p = 0.856; η2 = 0.004), was found. Moreover, there were no statistically significant main effects of intervention on time on muscle stiffness or tone (tone ($F_{(4,174)} = 0.659$; p = 0.582; η2 = 0.016; $F_{(4,174)} = 0.541$; p = 0.66; η2 = 0.012, respectively) . Although there was statistically significant effect of time on muscle tone ($F_{(2,174)} = 6.319$; p = 0.005; η2 = 0.068) and on stiffness ($F_{(2,174)} = 6.263$; p = 0.005; η2 = 0.067) . Post hoc indicate significant decline in tone only from pre to post2 measurement (p = 0.012) (Fig. 27) (Fig. 28), for stiffness there was significant decline form pre to post1 and post2 (p = 0.017, p = 0.029), but not from post1 to post2. Paired T-test shows significant decline for FR from pre to post1 (p = 0.01, p = 0.004) and from pre to post2 (p = 0.028, p = 0.045) for both muscle tone and stiffness respectively. The effect size, as measured by Cohen's d, when compared pre and post max was for CON d = 0.09, FLOSS d = 0.04, FR d = 0.25 for muscle tone and CON d = 0.06, FLOSS d = 0.04, FR d = 0.3 for muscle stiffness.

Fig. 27 The mean ± standard error (SE) values for muscle tone [Hz] of the BF left leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

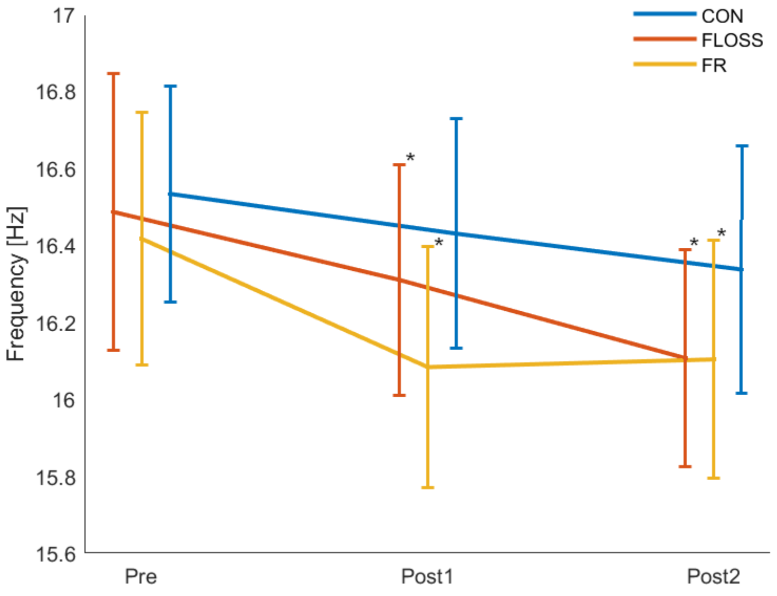
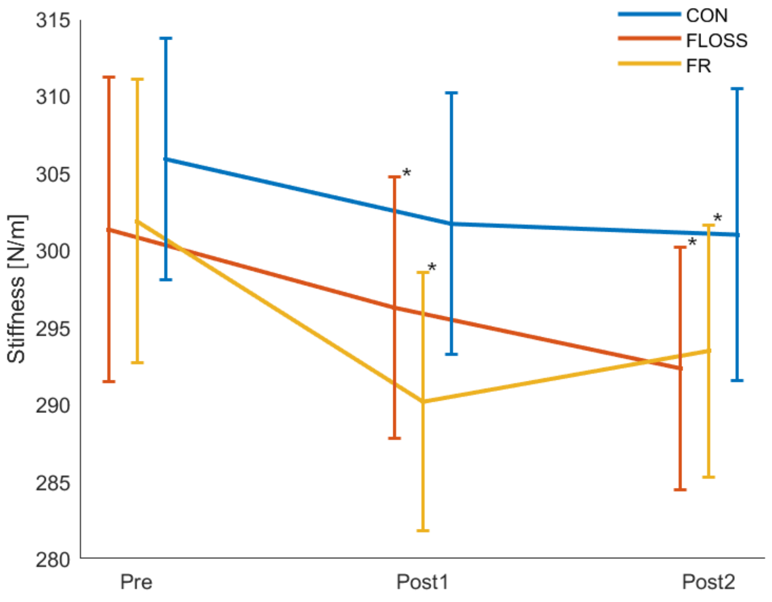


Fig. 28 The mean ± standard error (SE) values for stiffness [N/m] of the BF left leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning



7.2.3.2. Right lower limb

There were no statistically significant interactions found for muscle stiffness ($F_{(2,87)} = 0.317$; $p = 0.729$; $\eta2 = 0.007$) or tone ($F_{(2,87)} = 0.098$; $p = 0.907$; $\eta2 = 0.002$). Additionally, the intervention did not have a statistically significant main effect on muscle stiffness or tone over time (tone: $F_{(4,174)} = 0.734$; $p = 0.558$; $\eta2 = 0.017$; stiffness: $F_{(4,174)} = 0.774$; $p = 0.543$; $\eta2 = 0.017$). However, there was a statistically significant effect of time on muscle tone ($F_{(2,174)} = 4.806$; $p = 0.009$; $\eta2 = 0.052$) and stiffness ($F_{(2,174)} = 4.516$; $p = 0.012$; $\eta2 = 0.049$). Post hoc analysis indicated a significant decline in tone only from the pre-measurement to the second post-measurement ($p = 0.022$) (see Fig. 29). Same for stiffness, where was a significant decline only from the pre-measurement to second post-measurements ($p = 0.016$) (Fig. 30) (Table 5) (Table 6). For FR paired T-test shows significant decline in muscle tone and stiffness from pre to post1 ($p = 0.003$, $p = 0.002$, respectively) and from pre to post2 ($p = 0.005$, $p = 0.001$, respectively). The effect size, as measured by Cohen's d, when compared pre and post max was for CON d = 0.01, FLOSS d = 0.27, FR d = 0.23 for muscle tone and CON d = 0.01, FLOSS d = 026, FR d = 0.27 for muscle stiffness. Table 7 shows how many participants had positive, negative or did not respond to conditioning for muscle tone where Table 8 shows it for muscle stiffness when compared pre and post maximum value.

Fig. 29 The mean ± standard error (SE) values for muscle tone [Hz] of the BF right leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

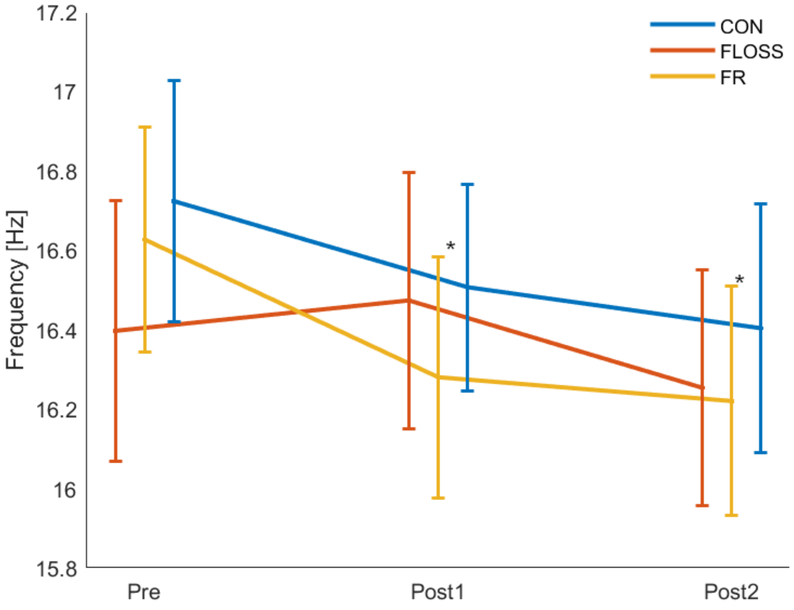


Fig. 30 The mean ± standard error (SE) values for stiffness [N/m] of the BF right leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

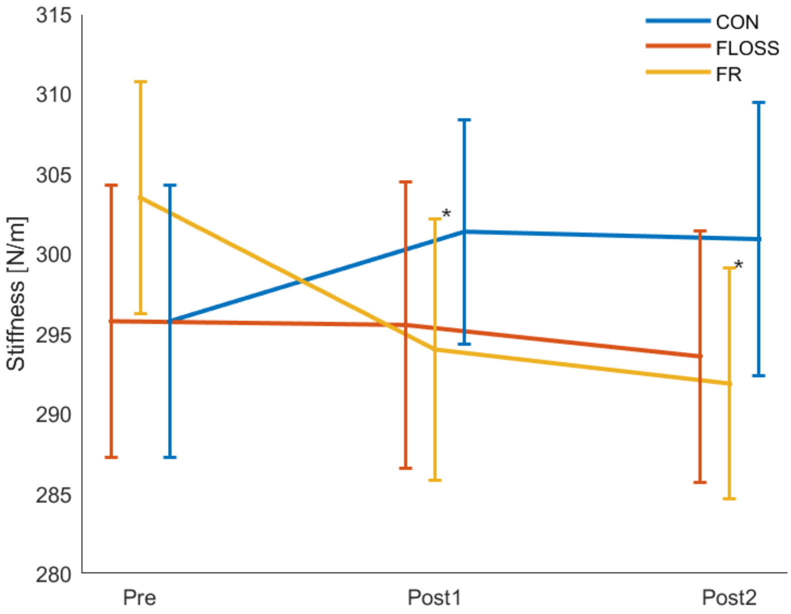


Table 5 The mean ± standard deviation (SD) values for muscle tone [Hz]. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning, Bic Fem c l - Biceps Femoris Caput longum, Rect – Rectus, Vastus lt- Vastus Lateralis

	Muscle	Frequency [Hz]			
		Pre	Post1	Post2	Post_Max
CON	Bic Fem c l left	16.53 ± 1.53	16.43 ± 1.64	16.34 ± 1.76	16.62 ± 1.72
	Bic Fem c l right	16.72 ± 1.66	16.51 ± 1.42	16.4 ± 1.71	16.74 ± 1.57
	Rect Femoris left	15.13 ± 0.73	14.93 ± 0.99	14.94 ± 0.99	15.22 ± 0.97
	Rect Femoris right	15.56 ± 0.99	15.5 ± 1.02	15.09 ± 0.99	15.5 ± 0.99
	Vastus lt left	17.35 ± 2.26	17.24 ± 2.12	16.96 ± 1.85	17.48 ± 2.13
	Vastus lt right	17.53 ± 1.74	17.29 ± 2.02	16.83 ± 1.61	17.57 ± 1.95
FLOSS	Bic Fem c l left	16.5 ± 1.96	16.3 ± 1.64	16.09 ± 1.55	16.44 ± 1.62
	Bic Fem c l right	16.44 ± 1.8	16.49 ± 1.77	16.44 ± 1.8	16.63 ± 1.78
	Rect Femoris left	15.16 ± 0.83	15.43 ± 0.93	14.97 ± 0.97	15.52 ± 0.92
	Rect Femoris right	15.6 ± 0.97	15.6 ± 0.93	15.13 ± 0.98	15.71 ± 0.83
	Vastus lt left	17.28 ± 1.97	17.49 ± 2.18	16.95 ± 2.08	17.69 ± 2.21
	Vastus lt right	17.7 ± 1.99	17.84 ± 2.22	16.89 ± 2	18.04 ± 2.06
FR	Bic Fem c l left	16.42 ± 1.8	16.08 ± 1.72	16.1 ± 1.69	16.24 ± 1.75
	Bic Fem c l right	16.63 ± 1.56	26.28 ± 1.66	16.63 ± 1.58	16.49 ± 1.69
	Rect Femoris left	15.24 ± 1.14	14.92 ± 0.84	14.86 ± 0.88	15.08 ± 0.84
	Rect Femoris right	15.5 ± 0.89	15.17 ± 0.95	15.09 ± 0.89	15.33 ± 0.93
	Vastus lt left	17.25 ± 2.1	16.43 ± 2.12	16.53 ± 2.12	16.7 ± 2.16
	Vastus lt right	17.38 ± 2.2	16.62 ± 1.69	16.5 ± 1.78	16.89 ± 1.79

Table 6 The mean ± standard deviation (SD) values for stiffness [N/m]. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning, Bic Fem c l - Biceps Femoris Caput longum, Rect – Rectus, Vastus lt- Vastus Lateralis

	Muscle	Stiffness [N/m]			
		Pre	Post1	Post2	Post_Max
CON	Bic Fem c l left	305.9 ± 43	301.7 ± 46.48	301 ± 51.98	307.33 ± 51.73
	Bic Fem c l right	308.37 ± 44.85	301.37 ± 38.41	300.9 ± 46.86	307.97 ± 43.45
	Rect Femoris left	261.33 ± 18.21	260.73 ± 21.98	256.1 ± 21.63	262.83 ± 21.22
	Rect Femoris right	266.93 ± 22.47	264 ± 24.23	258.53 ± 20.81	265.5 ± 23.44
	Vastus lt left	327.57 ± 51.47	325.6 ± 46.24	316.83 ± 38.48	328.2 ± 45.55
	Vastus lt right	332.12 ± 38.17	330.37 ± 42.81	314.17 ± 33.91	331.23 ± 42.17
FLOSS	Bic Fem c l left	302.27 ± 53.72	296.4 ± 46.41	292.37 ± 43.03	300 ± 46.26
	Bic Fem c l right	296.97 ± 46.34	295.83 ± 48.79	294.8 ± 42.81	300.93 ± 48.61
	Rect Femoris left	264 ± 21.34	267.37 ± 23.46	257.03 ± 20.27	269.57 ± 22.4
	Rect Femoris right	267.63 ± 22.57	271.4 ± 23.77	258.73 ± 21.51	274.13 ± 22.57
	Vastus lt left	323.57 ± 38.22	330.7 ± 49.04	315.33 ± 45.26	334.6 ± 49.81
	Vastus lt right	331.77 ± 36.84	337 ± 43.37	315.7 ± 33.49	341.63 ± 40.22
FR	Bic Fem c l left	301.87 ± 50.34	290.17 ± 45.87	293.17 ± 45.87	295.33 ± 45.36
	Bic Fem c l right	202.5 ± 39.74	294 ± 44.63	291.87 ± 39.45	299.6 ± 45.11
	Rect Femoris left	263.4 ± 20.07	253 ± 17.02	252.13 ± 20.82	255.87 ± 18.8
	Rect Femoris right	262.67 ± 20.9	256.17 ± 20.42	255.17 ± 21.45	260 ± 20
	Vastus lt left	325.8 ± 45.1	306.43 ± 38.84	308.97 ± 43.64	313.4 ± 42.62
	Vastus lt right	326.4 ± 40	311.23 ± 34.31	308.6 ± 34.9	316.67 ± 34.83

Table 7 Positive, negative and no-responses to the interventions for muscle tone [Hz]. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning, Bic Fem c l -Biceps Femoris Caput longum.

Muscle		CON		FR		FLOSS	
		Left	Right	Left	Right	Left	Right
Vastus Lateralis	Positive	16	15	5	8	20	19
	Negative	11	15	22	21	7	9
	No response	3	0	3	1	3	2
Rectus Femoris	Positive	14	10	10	9	20	18
	Negative	15	16	15	21	8	10
	No response	1	4	5	0	2	2
Biceps Femoris c l	Positive	20	19	11	11	18	20
	Negative	8	11	17	18	12	8
	No response	2	0	2	1	0	2

Table 8 Positive, negative and no-responses to the interventions for muscle stiffness [N/m]. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning, Bic Fem c l -Biceps Femoris Caput longum.

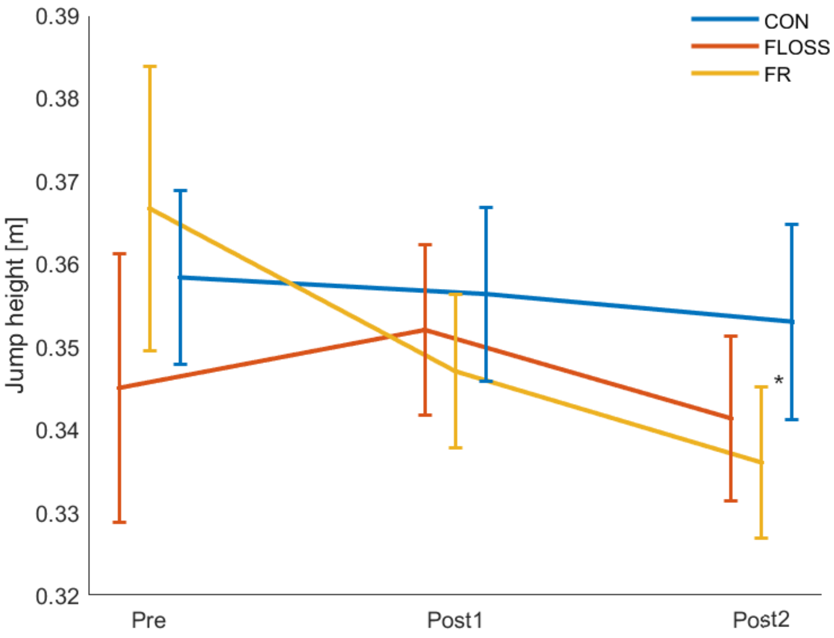
Muscle		CON		FR		FLOSS	
		Left	Right	Left	Right	Left	Right
Vastus Lateralis	Positive	21	14	4	9	21	22
	Negative	9	16	26	21	9	7
	No response	0	0	0	0	0	1
Rectus Femoris	Positive	13	13	8	11	20	19
	Negative	15	17	22	19	10	11
	No response	2	0	0	0	0	0
Biceps Femoris c l	Positive	17	19	9	9	17	20
	Negative	13	10	20	19	13	7
	No response	0	1	1	2	0	3

7.3. Jumping performance

7.3.1. Jump height

Two-way ANOVA didn't reveal statistically significant changes in jump height ($F_{(2,174)}$ = 2.614; p = 0.098; η2 = 0.029). Only significant drop for FR occurred from pre to post2 measurements (p = 0.05). Other results didn't indicate any significant changes. When compared pre with maximum post value for there was no significant difference between any of the interventions ($F_{(2,87)}$ = 0.309; p = 0.735) (Fig. 31). The effect size, as measured by Cohen's d, when compared pre and post max was for CON d = 0.15, FLOSS d = 0.13, FR d = 0.25.

Fig 31. The mean ± standard error (SE) values for Jump Height [m]. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning



7.3.2. Braking Rate of Force Development (RFD)

No significant main effect on braking rate of force development was observed ($F_{(2,176}$ = 0.044; p = 0.919; η2 = 0.057) for any of the interventions (Fig. 32), (Table 9). When compared pre with maximum post value there was no significant difference between any of the interventions ($F_{(2,87)} = 0.186$; $p = 0.831$), however there was significant difference between pre and maximum post value for tissue flossing ($p = 0.016$). The effect size, as measured by Cohen’s d, when compared pre and post max was for CON d = 0.11, FLOSS d = 0.57, FR d = 0.09. Table 10 shows how many participants had positive, negative or did not respond to conditioning for jump height and braking RFD when compared pre and post maximum value.

Fig 32 The mean ± standard error (SE) values for Braking Rate of Force Development (RFD) [m/s]. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

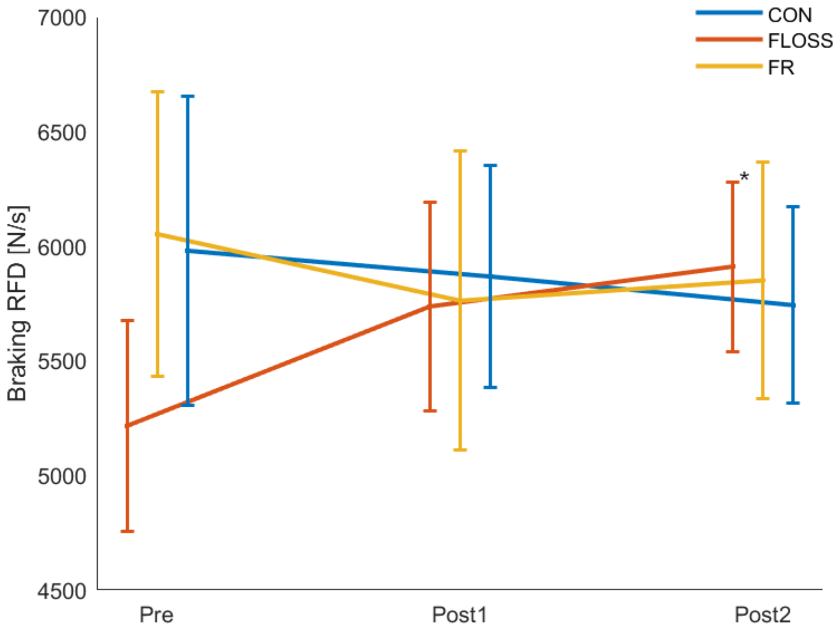


Table 9 The mean ± standard deviation (SD) values for Braking Rate of Force Development [N/s] and jump height [m]. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Intervention	Jump Height [m]			Braking Rate of Force Development [N/s]		
	Pre	Post1	Post2	Pre	Post1	Post2
CON	0.36 ± 0.06	0.36 ± 0.06	0.35 ± 0.06	5866 ± 2647	5741 ± 2352	5979 ± 3678
FLOSS	0.34 ± 0.09	0.35 ± 0.06	0.34 ± 0.05	5596 ± 2472	5738 ± 1945	5395 ± 2317
FR	0.37 ± 0.09	0.35 ± 0.05	0.34 ± 0.05	5761 ± 3573	5849 ± 2819	6051 ± 3407

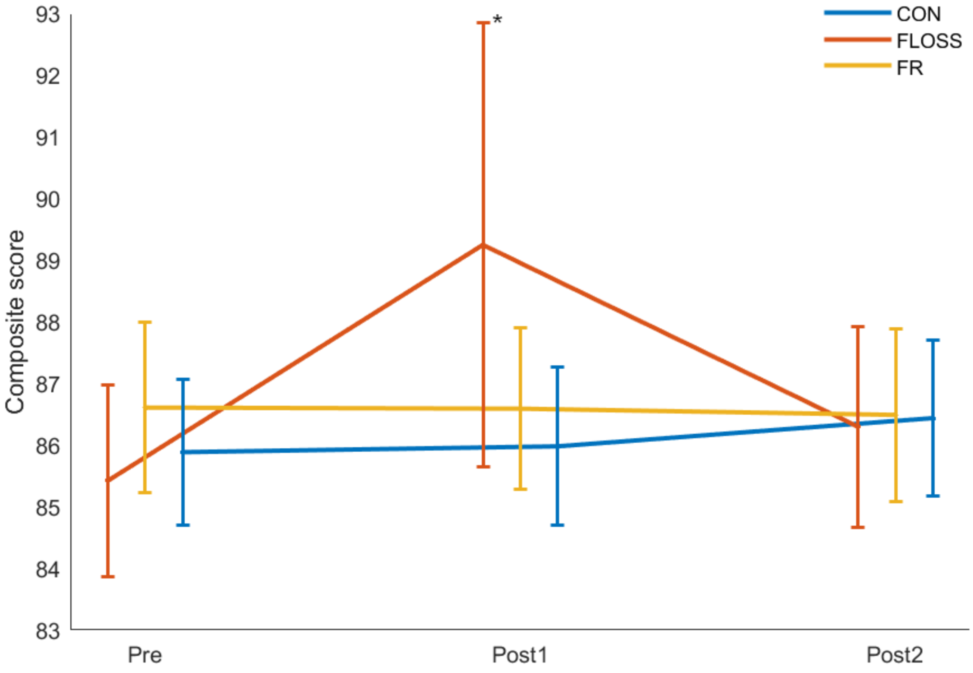
Table 10 Positive, negative and no-responses to the interventions for muscle tone [Hz]. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning, RFD- Rate of Force Development.

Conditioning	Jump height			BrakingRFD		
	Positive	Negative	No response	Positive	Negative	No response
CON	7	10	13	17	13	0
FR	8	17	5	18	12	0
FLOSS	9	12	10	24	7	0

7.4. Dynamic stability

No significant main effect was observed for right lower limb ($F_{(2,174)} = 1.102$; $p = 0.307$; $\eta2 = 0.013$). Moreover, there were no statistically significant main effects of intervention and time on dynamic stability on right leg ($F_{(4,174)} = 1.173$; $p = 0.318$; $\eta2 = 0.026$) (Fig.33). When compared pre with maximum post value for right leg there was no significant difference between any of the interventions ($F_{(2,87)} = 0.151$; $p = 0.86$), however there was significant difference between pre and maximum post value for tissue flossing ($p = 0.01$).

Fig. 33 The mean ± standard error (SE) values for Composite Score [%] of Y balance test for right leg. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning



There was statistically significant main effect on left lower limb ($F_{(2,174)} = 5.048$; $p = 0.007$; $\eta 2 = 0.055$). Additionally, there was statistically significant effect of intervention on time ($F_{(4,174)} = 2.699$; $p = 0.032$; $\eta 2 = 0.058$). Post hoc revealed significant effect between pre and post2 ($p = 0.007$) measurement but not between pre and post1 nor between post1 to post2 ($p = 0.2$, $p = 0.674$ respectively). However no statistically significant difference occurred between interventions ($F_{(2,87)} = 0.337$; $p = 0715$; $\eta 2 = 0.008$) (Fig. 34) (Table 11). FR shows statistically significant improvement in Composite Score for non-dominant leg form pre to post2 ($p < 0.001$). Paired T- test indicates significant difference for FR from pre to post2 measurements ($p = 0.007$) and from post1 to post2 ($p = 0.013$) for left leg. (Fig. 35) When compared pre with maximum post value for left leg there was no significant difference between any of the interventions ($F_{(2,87)} = 0.273$; $p = 0.762$), however there were significant difference between pre and maximum post value for tissue flossing ($p = 0.013$) and for foam rolling ($p < 0.001$). For right leg the effect size, as measured by Cohen's d, when compared pre and post max was for CON d = 0.41, FLOSS d = 0.28, FR d = 0.22, for left leg: CON d =

0.41, FLOSS d = 0.44, FR d = 0.59. Table 12 shows how many participants had positive, negative or did not respond to conditioning.

Fig. 34 The mean ± standard error (SE) values for Composite Score [%] of Y balance test for left leg. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

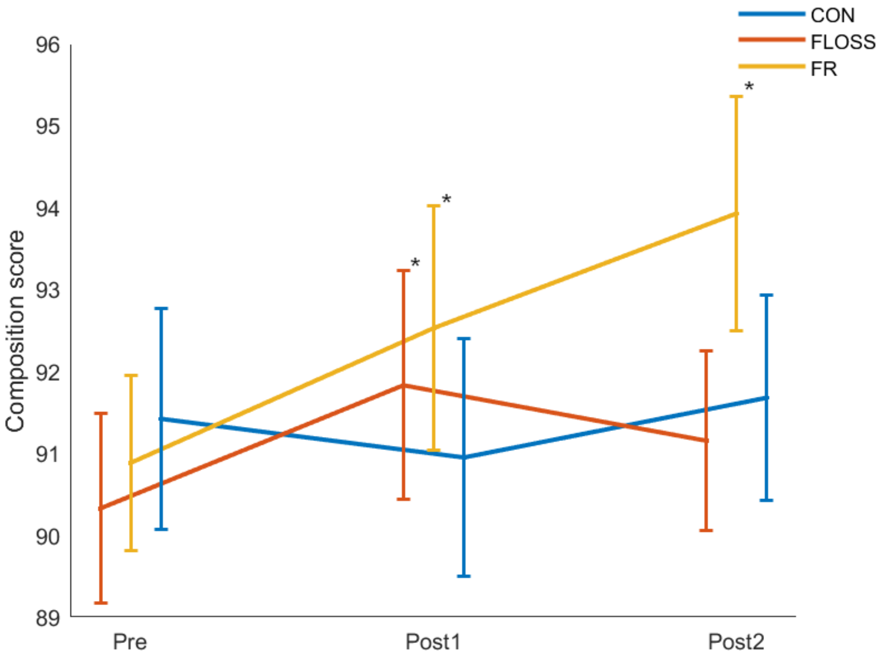


Fig. 35 Bar chart showing Y-balance composite score results. pre -purple bar; green – post1, yellow – post2. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

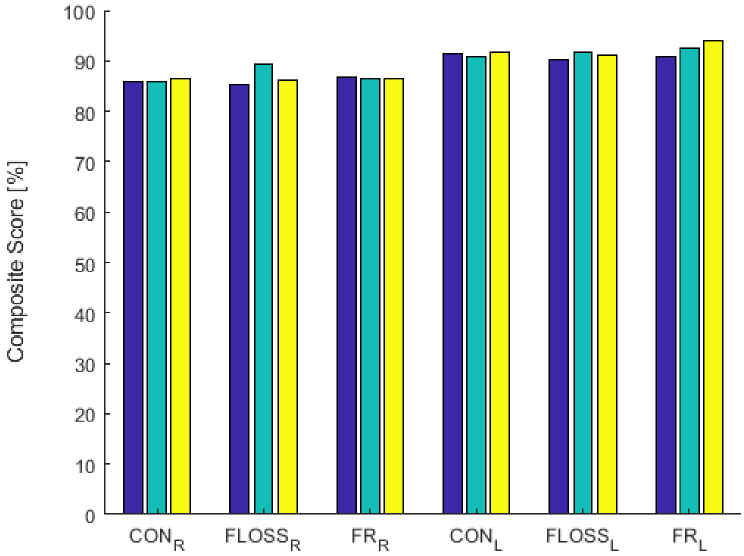


Table 11 The mean ± standard deviation (SD) values for Composite Score [%] of Y balance test. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Intervention	Side	Pre	Post1	Post2
CON	Right	85.88 ± 6.51	85.98 ± 7.01	86.44 ± 7.01
	Left	91.42 ± 7.38	90.95 ± 7.933	91.68 ± 6.86
FLOSS	Right	85.42 ± 8.48	89.24 ± 19.76	86.3 ± 8.91
	Left	90.33 ± 6.32	91.83 ± 7.64	91.15 ± 6.01
FR	Right	86.61 ± 7.54	86.59 ± 7.16	86.49 ± 7.67
	Left	90.88 ± 5.85	92.53 ± 8.18	93.93 ± 7.85

Table 12 Positive, negative and no-responses to the interventions for Y- balance test. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning.

Conditioning	Y-balance test Right			Y-balance test Left		
	Positive	Negative	No response	Positive	Negative	No response
CON	19	11	1	19	11	1
FR	18	10	2	22	7	1
FLOSS	22	6	2	18	11	1

8. Hypothesis evaluation

After evaluating the results, we can confirm or reject the individual hypotheses.

Alternative hypothesis 1: Tissue flossing applied to the thigh will improve jump performance, brakingRFD, and ROM.

Alternative hypothesis was confirmed only for the ROM. Tissue flossing didn't positively affect jump performance however improved brakingRFD when compared pre and post max results. Moreover, it had statistically significantly improved hamstring ROM ($F_{(2,58)} = 18.099$; $p < 0.001$; $\eta2 = 0.384$).

Alternative hypothesis 2: Tissue flossing will yield greater improvements in jump performance, ROM, dynamic stability, viscoelastic properties of the muscle, and brakingRFD compared to foam rolling.

Alternative hypothesis number 2 wasn't confirmed. None of the interventions shows significant improvement in jump height, whereas TF showed significant improvement for brakingRFD when compared pre and post max value. On the other hand FR showed significant decrease in jump height when compared pre and post mac measurements. Both of the interventions show significant improvement in AROM, however no significant difference between tissue flossing and foam rolling was revealed ($F_{(1,58)} = 0.154$; $p = 0.696$; $\eta2 = 0.003$). In addition, ANOVA analysis revealed no significant differences between the interventions in any of the measurements of viscoelastic properties. Nonetheless, there was a main effect of time on muscle tone and stiffness of measurements indicating significant differences between pre and post for all of the muscle and legs. For dynamic stability TF yielded significant improvement in composite score for right leg and left when compared pre and post max value whereas FR only for left leg. However no significant differences between conditions were observed.

Alternative hypothesis 3: Both the foam rolling and tissue flossing conditionings will demonstrate significant improvements when compared to the control conditioning.

Alternative hypothesis 2 was not supported by the data. None of the interventions demonstrated significant improvements compared to the control condition.

9. Discussion

9.1. Tissue flossing

Tissue flossing is a technique that involves wrapping a flexible band or floss around a specific joint or muscle group and performing various movements to create compression and shear forces. It is regarded as an innovative warm-up technique that has the potential to enhance joint flexibility without diminishing muscular strength and power (155). Our aim was to examine the effect of tissue flossing on hamstring AROM, jump performance, viscoelastic properties of Vastus Lateralis, Rectus Femoris and Biceps Femoris Caput Longum and dynamic stabilization with wrapping the thigh on both legs. Results shows that there is statistically significant improvement in AROM measurements for both legs which agrees with the results obtained by (140) where TF significantly enhanced straight leg raise test when compared to dynamic stretching and Cheatham (156) where TF significantly improved knee flexion. Tissue flossing also seems to positively impact ROM when applied on other part of body, in example Driller and Stevenson applied TF on ankle where it improved ankle ROM (157, 158), similarly application on calf positively affects ankle ROM (33, 140, 159). However, not all of the studies received positive feedback, Vogrin (38) when was evaluating effect of different application pressure didn’t obtain any significant improvement in ROM, neither Mills (160) after applying TF on ankle didn’t observe significant improvement. In the study conducted by Kaneda (161) comparing static stretching and tissue flossing, the static stretching group demonstrated a reduction in muscle stiffness with no significant change in stretch tolerance and no change in fascial length. Conversely, the tissue flossing group did not exhibit any changes in muscle stiffness and no change in fascial length was observed but received improve in ROM and passive torque at the end range of dorsiflexion. Similarly, our own findings indicated a significant improvement in AROM, but no changes in Biceps Femoris stiffness. Therefore an explanation for the observed increase in range of motion after a single application of tissue flossing is likely associated with an improvement in stretch tolerance (140), rather than alterations in the stiffness of the myotendinous tissue (161, 162). However, physiological mechanisms involved in changes in ROM remains unknown. Various authors have compared the effects of tissue flossing on ROM to those achieved through the application of pressure on muscles and fascia using a foam roller. While the exact physiological mechanisms underlying the effects of foam rolling are not yet fully understood, they can be categorized into two groups: neurophysiological and mechanical mechanisms focusing on fascial adjustment. According to Schleip (21), neurophysiological mechanisms may contribute to the effects of foam rolling. Additionally, Schleip and Müller (15) emphasize the mechanical mechanisms involved in fascial adjustments. In light of this, (140) suggest that the pressure exerted by tissue flossing on the skin, muscles, and fascia may impact fluid viscosity, resulting in reduced resistance to movement. Similar to the effects of pressure on the skin, muscle, or fascia, tissue flossing also induces vascular occlusion, which can be likened to ischemic preconditioning. Both tissue flossing and ischemic preconditioning techniques involve vascular occlusion, leading to a reduced supply of oxygen to the wrapped body part. A recent study conducted by Pavlů et al. (163) demonstrated that a two-minute application of tissue flossing resulted in a significant decrease in blood flow to the affected area. Ischemic conditioning can result in enhanced exercise performance (164), therefore it can be assumed that tissue flossing impact on performance enhancement may have a comparable underlying mechanism as blood flow restriction training. While our study did not show any jump height improvements, increase in braking RFD was shown when compared pre and maximum post measurements similarly as in study made by Kaneda (161). Several other studies have reported enhancements in jump (33, 135), sprint performance (33) after applying tissue flossing to the ankle or gastrocnemius muscle. These findings align with the results reported by Baumgart (34), who found a decrease in muscle stiffness following a single foam rolling session in the rectus femoris muscle but not in the gastrocnemius muscle. Therefore, it is possible that the outcomes of floss band treatment on different muscles may vary in terms of range of motion or their underlying mechanisms, such as changes in muscle stiffness. Interestingly, several studies were observed improvement in maximal voluntary contraction for knee extensors (38, 140) but in Konrad study it didn't align with improvement in CMJ (165). One possible explanation is that performance in activities such as jumps and explosive movements is predominantly influenced by the rapid development of force, known as rate of force development (RFD), and to a lesser extent by maximal strength (166). While the flossing intervention may have positively affected maximum isometric torque production, it may have had a limited impact on the rate of force development.

To date, no studies have assessed dynamic balance evaluation specifically after applying tissue flossing to the thigh. Only two studies have investigated the effects of tissue flossing on dynamic stabilization, with one study applying the band to the ankle (167) and the other to the knee (168). Both studies reported significant improvements in composite scores where after ankle application there was significant improvement in ANT direction and knee application in all directions. These findings agree with our own results, where we did observe significant improvement in dynamic balance in both legs when compared pre and post max value. Kinematic predictors of performance in the reach directions of the YBT indicate that hip flexion is significantly correlated with reach distances in all three directions. Additionally, knee flexion and contralateral torso rotation were found to increase the predictive capability of the model, but significantly correlated only with the anterior (ANT) direction (169). According to the study by Nakagawa and Petersen (170), the ANT direction in the Y Balance Test-Lower Quarter (YBT-LQ) demonstrated that dorsiflexion is a kinematic predictor. The study found that an increase in the ANT score can only occur if there is an increase in dorsiflexion. Based on these findings, it appears that the impact of tissue flossing on dynamic balance may vary depending on the specific application site and the directions of movement being evaluated.

This study reveals that TF has significantly increase muscle tone only immediately after application in Rectus Femoris on left leg whereas on right leg there was significant decline from pre to post1 and pre to post2 measurements. From post1 to post2 was already significant drop in muscle tone. For VL, RF on right side TF significantly decrease muscle tone and muscle stiffness. Our study aligns with the findings reported by Klich et al. (33), where a decrease in muscle stiffness was observed in the intermuscular septum between the medial and lateral heads of the gastrocnemius, as well as in Achilles tendon stiffness in general. This reduction in soft tissue stiffness following tissue flossing is thought to be a result of increased arterial blood flow and an automatic release of soft tissues and ankle structures, including capsules. However, it should be noted that the results of our study differ from the findings reported by Kaneda et al. (161) and Vogrin et al. (162). These studies did not observe any decrease in muscle stiffness after tissue flossing application on the calf, which contrasts with our and Klich results. These discrepancies may be attributed to variations in study design, and application pressure. It was observed that higher pressure applied with tissue flossing decrease its positive effect (33, 38, 171). The observed effects can be explained by the fact that neuromuscular fatigue and muscle activation are sensitive to pressure and can vary based on the degree of vascular occlusion (172). In our study, we employed a Kikuhime pressure sensor to monitor the applied pressure during tissue flossing. The pressure sensor provided real-time feedback to ensure that the pressure applied did not exceed 150 mmHg and was similar in both legs. This measurement limitation was put in place to maintain a safe and controlled pressure level during the tissue flossing intervention. In Kaneda (161) average applied pressure was 160 ± 3 mmHg which could affect the results.

9.2. Foam rolling

Results shows for FR significant improvement in ROM from pre to post1 for both left and right leg ($p < 0.001$, $p = 0.02$ respectively) and from pre to post2 for right leg ($p = 0.036$). Similar to our findings Junker (28) and Su (173) reported improved flexibility after FR. The increase in flexibility observed after foam rolling may be attributed to changes in the thixotropic properties of the fascia surrounding the muscle. Thixotropy refers to the ability of certain materials, including fascia, to become less viscous and more fluid-like when subjected to mechanical stress (22). During foam rolling, the technique involves applying direct and sweeping pressure on the soft tissue by rolling back and forth over a dense foam roller. This pressure and friction generated between the soft tissues and the foam roller can warm the fascia, promoting it to take on a more fluid-like state. As a result, the fascia becomes more pliable and elastic, leading to an improvement in soft tissue extensibility and greater flexibility (27, 174). Furthermore, the vigorous pressure applied during foam rolling may contribute to increased flexibility. This intense pressure can potentially overload the cutaneous receptors, which are responsible for sensory feedback. By overwhelming these receptors, the sensation of reaching the stretch endpoint may be dulled, resulting in increased stretch tolerance. This increased tolerance allows for further stretching and improved flexibility over time (27). It is worth noting that the mechanisms underlying the effects of foam rolling on fascia and flexibility are still being investigated.

Our study findings align with the results observed by Mayer (175), which demonstrated a significant decrease in connective tissue stiffness in experienced athletes. Similarly, in our study, we observed a significant decrease in muscle tone and muscle stiffness in the VL, RF, and BF muscles on both sides. The fact that our participants were experienced handball players could have influenced these results. Regular and intense physical activity, as experienced by athletes, can have an impact on muscle tone and stiffness (103). The repeated engagement in sport-specific movements and training may contribute to improved muscle flexibility and a reduction in muscle tone and stiffness. In our study we observed a significant decrease in viscoelastic properties of muscles, and this resulted in a significant decline in jump performance. These findings indicate that the changes in muscle tone and stiffness may have a direct impact on jump performance in the context of our study, which corresponds to Gervasi study (176). Fama and Bueti (177) proposed that the compressive force from foam rolling likely stimulates Golgi receptors through ischemic compression. Their research showed that using foam rolling as a warm-up negatively impacted jump performance, particularly in the countermovement jump, when compared to a dynamic warm-up. On the other hand, our findings, contrast with the results observed by Behara (149), where an improvement in vertical jump was reported, however muscle stiffness wasn't monitored. However, in his study longer FR application was applied with additional gluteus maximus, and gastrocnemius muscles added for conditioning. Based on these contrasting findings, it can be concluded that focusing solely on foam rolling the front and back part of the thigh may not be sufficient to enhance jump performance. The gluteus maximus and gastrocnemius muscles play significant roles in jump performance, and targeting these muscles in addition to the thigh muscles may be necessary for optimal improvements in jump performance. Another possible mechanism why decreases in jump height occurred in our study is that it could be caused by fatigue which occurred after FR (178, 179). It is important to consider that the effects of foam rolling can vary based on the specific muscles targeted, the duration of application, and individual variations among participants.

Interestingly foam rolling demonstrated a significant improvement in dynamic balance for the non-dominant limb while standing on the dominant side. One possible explanation for this observation could be related to the changes in AROM between the legs. It is possible that there was a nonsignificant decrease in active ROM for the left leg, while the right leg maintained its ROM after foam rolling. This difference in ROM between the legs may have influenced the dynamic balance performance when standing on the dominant side. Another potential explanation is that reducing voluntary muscle activation, which can occur due to factors such as swelling or stiffness, may contribute to a reduction in muscular function. Foam rolling has been suggested to help alleviate swelling and reduce stiffness in the muscles, potentially leading to improved muscle activation and function. By promoting a more optimal level of voluntary muscle activation, foam rolling could enhance the dynamic balance performance for the non-dominant limb on the dominant side (180). It is important to consider that these explanations are speculative and would require further investigation to confirm their validity. Factors such as individual variability, specific muscle imbalances, and other underlying physiological processes may also play a role in the observed effects. Further research is needed to elucidate the mechanisms underlying the observed improvements in dynamic balance after foam rolling and to determine the broader implications for muscular function and performance.

10. Conclusions

Our findings indicate that tissue flossing did not demonstrate superior improvements in range of motion, dynamic stabilization, muscle tone and stiffness, or jump performance compared to foam rolling. However, both tissue flossing and foam rolling showed significant improvements in hamstring flexibility. Considering that FR had a negative impact on jump height performance, but both were effective in improving hamstring flexibility, it is reasonable to suggest that method which is going to be as a part of a warm-up routine should be carefully selected based on our exercise objective. Athletes and individuals can choose either tissue flossing, or foam rolling based on personal preference, accessibility, or specific goals. It is important to note that individual responses to these techniques may vary, and some individuals may find one method more effective or suitable for their needs. Therefore, it is recommended for individuals to experiment and determine which method works best for them in terms of warm-up, flexibility, and overall performance enhancement.

The outcomes of the study may be influenced by the specific exercises carried out while the floss band was applied. For some participants, these exercises were relatively easy, while for others, they caused significant discomfort and pain during the floss band application. To mitigate such variability, it would be beneficial to measure participants' perceived exertion levels. Classifying participants based on their perceived difficulty in performing the exercises could offer a more nuanced understanding of the results.

11. References

1. Langevin HM. Fascia Mobility, Proprioception, and Myofascial Pain. Life (Basel, Switzerland). 2021;11(7).

2. Runyeon LMBSDAHRHJKMLPMKM-GDQaJ. Anatomy & Physiology: OpenStax/Oregon State University; 2019.

3. Bochenek A, Reicher MJP, Warszawa. Anatomia człowieka, tom I: Anatomia ogólna, kości, stawu, więzadła i mięśnie, Wyd. 1978.

4. Goldman Y, Ostap E. Introduction to Molecular Motors and Motility. 2017.

5. Pham S, Puckett Y. Physiology, Skeletal Muscle Contraction. StatPearls. Treasure Island (FL) ineligible companies. Disclosure: Yana Puckett declares no relevant financial relationships with ineligible companies.: StatPearls Publishing

6. Herzog W, Leonard TR. Force enhancement following stretching of skeletal muscle: a new mechanism. The Journal of experimental biology. 2002;205(Pt 9):1275-83.

7. Herzog W, Schachar R, Leonard TR. Characterization of the passive component of force enhancement following active stretching of skeletal muscle. The Journal of experimental biology. 2003;206(Pt 20):3635-43.

8. Herzog W, Lee EJ, Rassier DE. Residual force enhancement in skeletal muscle. The Journal of physiology. 2006;574(Pt 3):635-42.

9. Anderson BR, Bogomolovas J, Labeit S, Granzier H. The effects of PKCalpha phosphorylation on the extensibility of titin's PEVK element. Journal of structural biology. 2010;170(2):270-7.

10. Feher J. 4.4 - Spinal Reflexes. In: Feher J, editor. Quantitative Human Physiology (Second Edition). Boston: Academic Press; 2012. p. 400-8.

11. Wise SP, Shadmehr R. Motor Control. In: Ramachandran VS, editor. Encyclopedia of the Human Brain. New York: Academic Press; 2002. p. 137-57.

12. Jelvéus A. 6 - Soft tissue stretching in sports massage. In: Jelvéus A, editor. Integrated Sports Massage Therapy. Edinburgh: Churchill Livingstone; 2011. p. 75-95.

13. Mileusnic MP, Loeb GE. Mathematical models of proprioceptors. II. Structure and function of the Golgi tendon organ. Journal of neurophysiology. 2006;96(4):1789-802.

14. Schleip R, Wilke J, Baker A, Findley TW. Fascia in Sport and Movement, Second Edition: Handspring Publishing Limited; 2021.

15. Schleip R, Müller DG. Training principles for fascial connective tissues: scientific foundation and suggested practical applications. J Bodyw Mov Ther. 2013;17(1):103-15.

16. Mauntel TC, Clark MA, Padua DAJAT, Care SH. Effectiveness of myofascial release therapies on physical performance measurements: A systematic review. 2014;6(4):189-96.

17. Findley T, Chaudhry H, Dhar S. Transmission of muscle force to fascia during exercise. J Bodyw Mov Ther. 2015;19(1):119-23.

18. Stecco C, Gagey O, Belloni A, Pozzuoli A, Porzionato A, Macchi V, et al. Anatomy of the deep fascia of the upper limb. Second part: study of innervation. Morphologie : bulletin de l'Association des anatomistes. 2007;91(292):38-43.

19. Schleip R, Gabbiani G, Wilke J, Naylor I, Hinz B, Zorn A, et al. Fascia Is Able to Actively Contract and May Thereby Influence Musculoskeletal Dynamics: A Histochemical and Mechanographic Investigation. Front Physiol. 2019;10:336.

20. Schleip R, Duerselen L, Vleeming A, Naylor IL, Lehmann-Horn F, Zorn A, et al. Strain hardening of fascia: static stretching of dense fibrous connective tissues can induce a temporary stiffness increase accompanied by enhanced matrix hydration. J Bodyw Mov Ther. 2012;16(1):94-100.

21. Schleip R. Fascial plasticity - A new neurobiological explanation: Part 1. Journal of Bodywork and Movement Therapies. 2003;7:11-9.

22. Schleip R. Fascial plasticity - A new neurobiological explanation. Part 2. Journal of Bodywork and Movement Therapies. 2003;7:104-16.

23. Weerapong P, Hume PA, Kolt GS. The mechanisms of massage and effects on performance, muscle recovery and injury prevention. Sports Med. 2005;35(3):235-56.

24. Gehlsen GM, Ganion LR, Helfst R. Fibroblast responses to variation in soft tissue mobilization pressure. Medicine and science in sports and exercise. 1999;31(4):531-5.

25. Wilke J, Müller A-L, Giesche F, Power G, Ahmedi H, Behm DG. Acute Effects of Foam Rolling on Range of Motion in Healthy Adults: A Systematic Review with Multilevel Meta-analysis. Sports Medicine. 2020;50(2):387-402.

26. Aboodarda SJ, Spence AJ, Button DC. Pain pressure threshold of a muscle tender spot increases following local and non-local rolling massage. BMC musculoskeletal disorders. 2015;16:265.

27. MacDonald GZ, Penney MD, Mullaley ME, Cuconato AL, Drake CD, Behm DG, et al. An acute bout of self-myofascial release increases range of motion without a subsequent decrease in muscle activation or force. Journal of strength and conditioning research. 2013;27(3):812-21.

28. Junker DH, Stöggl TL. The Foam Roll as a Tool to Improve Hamstring Flexibility. Journal of strength and conditioning research. 2015;29(12):3480-5.

29. Mohr AR, Long BC, Goad CL. Effect of foam rolling and static stretching on passive hip-flexion range of motion. J Sport Rehabil. 2014;23(4):296-9.

30. Hendricks S, Hill Hn, Hollander Sd, Lombard W, Parker R. Effects of foam rolling on performance and recovery: A systematic review of the literature to guide practitioners on the use of foam rolling. Journal of Bodywork and Movement Therapies. 2020;24(2):151-74.

31. Beardsley C, Škarabot J. Effects of self-myofascial release: A systematic review. J Bodyw Mov Ther. 2015;19(4):747-58.

32. Young JD, Spence AJ, Behm DG. Roller massage decreases spinal excitability to the soleus. Journal of applied physiology (Bethesda, Md : 1985). 2018;124(4):950-9.

33. Klich S, Smoter M, Michalik K, Bogdański B, Valera Calero JA, Manuel Clemente F, et al. Foam rolling and tissue flossing of the triceps surae muscle: an acute effect on Achilles tendon stiffness, jump height and sprint performance – a randomized controlled trial. Research in Sports Medicine. 2022:1-14.

34. Baumgart C, Freiwald J, Kühnemann M, Hotfiel T, Hüttel M, Hoppe MW. Foam Rolling of the Calf and Anterior Thigh: Biomechanical Loads and Acute Effects on Vertical Jump Height and Muscle Stiffness. Sports (Basel, Switzerland). 2019;7(1).

35. Jones A, Brown L, Coburn J, Noffal G. Effects of Foam Rolling on Vertical Jump Performance. International Journal of Kinesiology & Sports Science. 2015;3:38-42.

36. Thalhamer C. A fundamental critique of the fascial distortion model and its application in clinical practice. Journal of Bodywork and Movement Therapies. 2018;22(1):112-7.

37. Typaldos S. Introducing the fascial distortion model. AAO Journal. 1994;4(2):14-8.

38. Vogrin M, Kalc M, Ličen T. Acute Effects of Tissue Flossing Around the Upper Thigh on Neuromuscular Performance: A Study Using Different Degrees of Wrapping Pressure. J Sport Rehabil. 2020;30(4):601-8.

39. Cheatham SW, Lee M, Cain M, Baker R. The efficacy of instrument assisted soft tissue mobilization: a systematic review. The Journal of the Canadian Chiropractic Association. 2016;60(3):200-11.

40. Davidson CJ, GANION LR, GEHLSEN GM, Verhoestra B, ROEPKE JE, SEVIER TL. Rat tendon morphologic and functional changes resulting from soft tissue mobilization. Medicine & Science in Sports & Exercise. 1997;29(3):313-9.

41. M. Gehlsen G, R. Ganion L, Helfst R. Fibroblast Response to Variation in Soft Tissue Mobilization and Pressure1999. 531-5 p.

42. Loghmani MT, Warden SJ. Instrument-assisted cross-fiber massage accelerates knee ligament healing. journal of orthopaedic & sports physical therapy. 2009;39(7):506-14.

43. Ahlhorn A, Krämer D. Flossing in Therapie und Training: Riva Verlag; 2016.

44. Abdulla SYJTJotCCA. Becoming a Supple Leopard: The Ultimate Guide To Resolving Pain, Preventing Injury, and Optimizing Athletic Performance. 2014;58(3):328.

45. Taradaj J, Rosińczuk J, Dymarek R, Halski T, Schneider WJT, management cr. Comparison of efficacy of the intermittent pneumatic compression with a high-and low-pressure application in reducing the lower limbs phlebolymphedema. 2015:1545-54.

46. Zaleska MT, Olszewski WLJLR, Biology. The effectiveness of intermittent pneumatic compression in therapy of lymphedema of lower limbs: methods of evaluation and results. 2019;17(1):60-9.

47. Schleip R. Faszien und Nervensystem. Osteopathische Medizin Zeitschrift für ganzheitliche Heilverfahren. 2003;4:20-8.

48. Kreutzer R. Flossing: Quintessence Publishing; 2016.

49. Seidenspinner D, Kolster B. Medical Flossing Intervention bei persistierenden Kniebeschwerden mit einem elastischen Band bei isokinetischer und EMG-gestützter Untersuchung vor und nach der Kompression des Kniegelenks. 2015.

50. Scott BR, Loenneke JP, Slattery KM, Dascombe BJ. Exercise with blood flow restriction: an updated evidence-based approach for enhanced muscular development. Sports Med. 2015;45(3):313-25.

51. Marliss EB, Vranic M. Intense exercise has unique effects on both insulin release and its roles in glucoregulation: implications for diabetes. Diabetes. 2002;51 Suppl 1:S271-83.

52. Moore DR, Burgomaster KA, Schofield LM, Gibala MJ, Sale DG, Phillips SM. Neuromuscular adaptations in human muscle following low intensity resistance training with vascular occlusion. Eur J Appl Physiol. 2004;92(4-5):399-406.

53. Schoenfeld BJ. Potential mechanisms for a role of metabolic stress in hypertrophic adaptations to resistance training. Sports Med. 2013;43(3):179-94.

54. Park SY, Kwak YS, Harveson A, Weavil JC, Seo KE. Low intensity resistance exercise training with blood flow restriction: insight into cardiovascular function, and skeletal muscle hypertrophy in humans. The Korean journal of physiology & pharmacology : official journal of the Korean Physiological Society and the Korean Society of Pharmacology. 2015;19(3):191-6.

55. Jones MT, Fleming A, Hornikel B, Saffold K, Winchester L, editors. Impact Of Traditional Blood Flow Restriction Versus Band Tissue Flossing On Metabolism And Performance. International Journal of Exercise Science: Conference Proceedings; 2022.

56. Moromizato K, Kimura R, Fukase H, Yamaguchi K, Ishida H. Whole-body patterns of the range of joint motion in young adults: masculine type and feminine type. Journal of Physiological Anthropology. 2016;35(1):23.

57. Taha S, Aly S, Kamel E, Hussien H. Normal active range of motion of lower extremity joints of the healthy young adults in Cairo, Egypt. Bulletin of Faculty of Physical Therapy. 2020;25:2.

58. Page P. Current concepts in muscle stretching for exercise and rehabilitation. Int J Sports Phys Ther. 2012;7(1):109-19.

59. Small K, Mc Naughton L, Matthews M. A Systematic Review into the Efficacy of Static Stretching as Part of a Warm-Up for the Prevention of Exercise-Related Injury. Research in Sports Medicine. 2008;16(3):213-31.

60. Medeiros DM, Cini A, Sbruzzi G, Lima CS. Influence of static stretching on hamstring flexibility in healthy young adults: Systematic review and meta-analysis. Physiotherapy Theory and Practice. 2016;32(6):438-45.

61. CRAMER JT, HOUSH TJ, JOHNSON GO, MILLER JM, COBURN JW, BECK TW. ACUTE EFFECTS OF STATIC STRETCHING ON PEAK TORQUE IN WOMEN. 2004;18(2):236-41.

62. Behm DG, Kay AD, Trajano GS, Blazevich AJ. Mechanisms underlying performance impairments following prolonged static stretching without a comprehensive warm-up. Eur J Appl Physiol. 2021;121(1):67-94.

63. Kubo K, Kanehisa H, Kawakami Y, Fukunaga T. Influence of static stretching on viscoelastic properties of human tendon structures in vivo. Journal of Applied Physiology. 2001;90(2):520-7.

64. Behm DG, Kibele A. Effects of differing intensities of static stretching on jump performance. European Journal of Applied Physiology. 2007;101(5):587-94.

65. Allen DG, Whitehead NP, Yeung EW. Mechanisms of stretch-induced muscle damage in normal and dystrophic muscle: role of ionic changes. The Journal of physiology. 2005;567(Pt 3):723-35.

66. Sayers AL, Farley RS, Fuller DK, Jubenville CB, Caputo JL. The Effect of Static Stretching on Phases of Sprint Performance in Elite Soccer Players. 2008;22(5):1416-21.

67. Caliskan E, Akkoc O, Bayramoglu Z, Gozubuyuk OB, Kural D, Azamat S, et al. Effects of static stretching duration on muscle stiffness and blood flow in the rectus femoris in adolescents. 2019;21(2):136-43.

68. Behm DG, Chaouachi A. A review of the acute effects of static and dynamic stretching on performance. European Journal of Applied Physiology. 2011;111(11):2633-51.

69. Herman SL, Smith DT. Four-Week Dynamic Stretching Warm-up Intervention Elicits Longer-Term Performance Benefits. 2008;22(4):1286-97.

70. Mizuno T. Changes in joint range of motion and muscle–tendon unit stiffness after varying amounts of dynamic stretching. Journal of Sports Sciences. 2017;35(21):2157-63.

71. Amiri-Khorasani M, Abu Osman NA, Yusof A. Acute Effect of Static and Dynamic Stretching on Hip Dynamic Range of Motion During Instep Kicking in Professional Soccer Players. 2011;25(6):1647-52.

72. Hough PA, Ross EZ, Howatson GJTJoS, Research C. Effects of dynamic and static stretching on vertical jump performance and electromyographic activity. 2009;23(2):507-12.

73. Fletcher IMJEjoap. The effect of different dynamic stretch velocities on jump performance. 2010;109:491-8.

74. Cuissard N, Duchateau J, Hainaut KJEJoAP, Physiology O. Muscle stretching and motoneuron excitability. 1988;58(1-2):47-52.

75. THACKER SB, GILCHRIST J, STROUP DF, KIMSEY CDJ. The Impact of Stretching on Sports Injury Risk: A Systematic Review of the Literature. 2004;36(3):371-8.

76. Kay AD, Husbands-Beasley J, Blazevich AJ. Effects of Contract–Relax, Static Stretching, and Isometric Contractions on Muscle–Tendon Mechanics. Medicine & Science in Sports & Exercise. 2015;47(10).

77. Kolber M, Hanney W. The reliability and concurrent validity of shoulder mobility measurements using a digital inclinometer and goniometer: A technical report. International journal of sports physical therapy. 2012;7:306-13.

78. Mayorga-Vega D, Merino-Marban R, Viciana J. Criterion-Related Validity of Sit-And-Reach Tests for Estimating Hamstring and Lumbar Extensibility: A Meta-Analysis. Journal of sports science & medicine. 2014;13:1-14.

79. Baltaci G, Un N, Tunay V, Besler A, Gerçeker S. Comparison of three different sit and reach tests for measurement of hamstring flexibility in female university students. Br J Sports Med. 2003;37(1):59-61.

80. Langarika-Rocafort A, Emparanza JI, Aramendi JF, Castellano J, Calleja-González J. Intra-rater reliability and agreement of various methods of measurement to assess dorsiflexion in the Weight Bearing Dorsiflexion Lunge Test (WBLT) among female athletes. Physical Therapy in Sport. 2017;23:37-44.

81. Jones CJ, Rikli RE, Max J, Noffal G. The reliability and validity of a chair sit-and-reach test as a measure of hamstring flexibility in older adults. Research quarterly for exercise and sport. 1998;69(4):338-43.

82. Manzoor I, Bacha R, Gilani SA. Diagnostic accuracy of sonoelastography in different diseases. Journal of ultrasonography. 2018;18(72):29-36.

83. Wu CH, Chang KV, Mio S, Chen WS, Wang TG. Sonoelastography of the plantar fascia. Radiology. 2011;259(2):502-7.

84. Taylor LS, Porter BC, Rubens DJ, Parker KJ. Three-dimensional sonoelastography: principles and practices. Physics in medicine and biology. 2000;45(6):1477-94.

85. Winn N, Lalam R, Cassar-Pullicino V. Sonoelastography in the musculoskeletal system: Current role and future directions. World journal of radiology. 2016;8(11):868-79.

86. Feng YN, Li YP, Liu CL, Zhang ZJ. Assessing the elastic properties of skeletal muscle and tendon using shearwave ultrasound elastography and MyotonPRO. Scientific Reports. 2018;8(1):17064.

87. Fröhlich-Zwahlen AK, Casartelli NC, Item-Glatthorn JF, Maffiuletti NA. Validity of resting myotonometric assessment of lower extremity muscles in chronic stroke patients with limited hypertonia: a preliminary study. J Electromyogr Kinesiol. 2014;24(5):762-9.

88. Davidson MJ, Bryant AL, Bower WF, Frawley HC. Myotonometry Reliably Measures Muscle Stiffness in the Thenar and Perineal Muscles. Physiother Can. 2017;69(2):104-12.

89. Chen G, Wu J, Chen G, Lu Y, Ren W, Xu W, et al. Reliability of a portable device for quantifying tone and stiffness of quadriceps femoris and patellar tendon at different knee flexion angles. PLOS ONE. 2019;14(7):e0220521.

90. Ko C-Y, Choi H-J, Ryu J, Kim G. Between-day reliability of MyotonPRO for the non-invasive measurement of muscle material properties in the lower extremities of patients with a chronic spinal cord injury. Journal of biomechanics. 2018;73:60-5.

91. Kim DH, Jung Y, Song Y, Hwang D, Ko C-Y, Kim H. 1C5-1 Measurement of Characteristic Change using MyotonPRO in Low Back Muscles during a Long-term Driving; Pilot Study. The Japanese journal of ergonomics. 2015;51:S450-S3.

92. Ngeo J, Tamei T, Shibata T. Estimation of continuous multi-DOF finger joint kinematics from surface EMG using a multi-output Gaussian Process. 2014 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, EMBC 2014. 2014;2014:3537-40.

93. Kuźma T, Pisz A, Łabuz-Roszak M, Kozarska M, Szindler M, Roszak MJAoMS, et al. Visualisation of ankle injury using a thermal imaging camera. 2016;80(2):59--63.

94. Daly S. Biophotonics for blood analysis. Biophotonics for Medical Applications: Elsevier; 2015. p. 243-99.

95. Kruse RA, Christiansen JAJAopm, rehabilitation. Thermographic imaging of myofascial trigger points: a follow-up study. 1992;73(9):819-23.

96. Diakow PJJom, therapeutics p. Differentiation of active and latent trigger points by thermography. 1992;15(7):439-41.

97. Diakow PJJoM, Therapeutics P. Thermographic imaging of myofascial trigger points. 1988;11(2):114-7.

98. Swerdlow B, Dieter JNI. An evaluation of the sensitivity and specificity of medical thermography for the documentation of myofascial trigger points. Pain. 1992;48(2):205-13.

99. Shah JP, Phillips TM, Danoff JV, Gerber LH. An in vivo microanalytical technique for measuring the local biochemical milieu of human skeletal muscle. Journal of Applied Physiology. 2005;99(5):1977-84.

100. Chaurasia CSJBC. In vivo microdialysis sampling: theory and applications. 1999;13(5):317-32.

101. Hawker GA, Mian S, Kendzerska T, French M. Measures of adult pain: Visual Analog Scale for Pain (VAS Pain), Numeric Rating Scale for Pain (NRS Pain), McGill Pain

Questionnaire (MPQ), Short-Form McGill Pain Questionnaire (SF-MPQ), Chronic Pain Grade Scale (CPGS), Short Form-36 Bodily Pain Scale (SF-36 BPS), and Measure of Intermittent and Constant Osteoarthritis Pain (ICOAP). Arthritis Care & Research. 2011;63(S11):S240-S52.

102. Nichols TR, Huyghues-Despointes CMJI. Muscular Stiffness. In: Binder MD, Hirokawa N, Windhorst U, editors. Encyclopedia of Neuroscience. Berlin, Heidelberg: Springer Berlin Heidelberg; 2009. p. 2515-9.

103. Brazier J, Bishop C, Simons C, Antrobus M, Read PJ, Turner AN. Lower Extremity Stiffness: Effects on Performance and Injury and Implications for Training. Strength & Conditioning Journal. 2014;36(5).

104. Proske U, Morgan DL, Gregory JE. Thixotropy in skeletal muscle and in muscle spindles: a review. Progress in neurobiology. 1993;41(6):705-21.

105. Joyce GC, Rack PM, Westbury DR. The mechanical properties of cat soleus muscle during controlled lengthening and shortening movements. The Journal of physiology. 1969;204(2):461-74.

106. Malamud JG, Godt RE, Nichols TR. Relationship between short-range stiffness and yielding in type-identified, chemically skinned muscle fibers from the cat triceps surae muscles. Journal of neurophysiology. 1996;76(4):2280-9.

107. Lin DC, Rymer WZ. Mechanical properties of cat soleus muscle elicited by sequential ramp stretches: implications for control of muscle. Journal of neurophysiology. 1993;70(3):997-1008.

108. Nichols TR, Houk JC. Improvement in linearity and regulation of stiffness that results from actions of stretch reflex. Journal of neurophysiology. 1976;39(1):119-42.

109. Huyghues-Despointes CM, Cope TC, Nichols TR. Intrinsic properties and reflex compensation in reinnervated triceps surae muscles of the cat: effect of movement history. Journal of neurophysiology. 2003;90(3):1547-55.

110. Haftel VK, Bichler EK, Nichols TR, Pinter MJ, Cope TC. Movement reduces the dynamic response of muscle spindle afferents and motoneuron synaptic potentials in rat. Journal of neurophysiology. 2004;91(5):2164-71.

111. Hortobágyi T, DeVita P. Muscle pre- and coactivity during downward stepping are associated with leg stiffness in aging. Journal of electromyography and kinesiology : official journal of the International Society of Electrophysiological Kinesiology. 2000;10(2):117-26.

112. Flitney E, Hirst D. Filament sliding and energy absorbed by the cross-bridge in active muscle subjected to cycical length changes. The Journal of physiology. 1978;276:467-79.

113. Morgan DL, Proske U, Warren D. Measurements of muscle stiffness and the mechanism of elastic storage of energy in hopping kangaroos. The Journal of physiology. 1978;282:253-61.

114. Farley CT, González OKJJob. Leg stiffness and stride frequency in human running. 1996;29 2:181-6.

115. Farley C, Blickhan R, Saito J, Taylor C. Hopping frequency in humans: A test of how springs set stride frequency in bouncing gaits. Journal of applied physiology (Bethesda, Md : 1985). 1992;71:2127-32.

116. Farley CT, Morgenroth DC. Leg stiffness primarily depends on ankle stiffness during human hopping. Journal of biomechanics. 1999;32(3):267-73.

117. Kubo K, Ikebukuro T. Changes in joint, muscle, and tendon stiffness following repeated hopping exercise. Physiol Rep. 2019;7(19):e14237.

118. Burkholder TJ. Permeability of C2C12 myotube membranes is influenced by stretch velocity. Biochemical and biophysical research communications. 2003;305(2):266-70.

119. Rassier DE, MacIntosh BR, Herzog W. Length dependence of active force production in skeletal muscle. Journal of applied physiology (Bethesda, Md : 1985). 1999;86(5):1445-57.

120. Ando R, Taniguchi K, Kikuchi S, Mizoguchi S, Fujimiya M, Katayose M, et al. Sarcomere length of the vastus intermedius with the knee joint angle change. Physiol Rep. 2021;9(5):e14771.

121. Iwata M, Yamamoto A, Matsuo S, Hatano G, Miyazaki M, Fukaya T, et al. Dynamic Stretching Has Sustained Effects on Range of Motion and Passive Stiffness of the Hamstring Muscles. J Sports Sci Med. 2019;18(1):13-20.

122. Arnold EM, Hamner SR, Seth A, Millard M, Delp SL. How muscle fiber lengths and velocities affect muscle force generation as humans walk and run at different speeds. The Journal of experimental biology. 2013;216(Pt 11):2150-60.

123. McHugh MP, Connolly DAJ, Eston RG, Kremenic IJ, Nicholas SJ, Gleim GW. The Role of Passive Muscle Stiffness in Symptoms of Exercise-Induced Muscle Damage. The American Journal of Sports Medicine. 1999;27(5):594-9.

124. Brughelli M, Cronin J. Influence of running velocity on vertical, leg and joint stiffness : modelling and recommendations for future research. Sports Med. 2008;38(8):647-57.

125. Butler RJ, Crowell HP, 3rd, Davis IM. Lower extremity stiffness: implications for performance and injury. Clinical biomechanics (Bristol, Avon). 2003;18(6):511-7.

126. Serpell BG, Ball NB, Scarvell JM, Smith PN. A review of models of vertical, leg, and knee stiffness in adults for running, jumping or hopping tasks. J Sports Sci. 2012;30(13):1347-63.

127. Kubo K, Kawakami Y, Fukunaga T. Influence of elastic properties of tendon structures on jump performance in humans. Journal of applied physiology (Bethesda, Md : 1985). 1999;87(6):2090-6.

128. Anderson FC, Pandy MG. Storage and utilization of elastic strain energy during jumping. Journal of biomechanics. 1993;26(12):1413-27.

129. Kubo K, Kanehisa H, Fukunaga T. Effects of viscoelastic properties of tendon structures on stretch-shortening cycle exercise in vivo. J Sports Sci. 2005;23(8):851-60.

130. Kalkhoven JT, Watsford ML. The relationship between mechanical stiffness and athletic performance markers in sub-elite footballers. J Sports Sci. 2018;36(9):1022-9.

131. Arampatzis A, Schade F, Walsh M, Brüggemann G-P. Influence of leg stiffness and its effect on myodynamic jumping performance. Journal of Electromyography and Kinesiology. 2001;11(5):355-64.

132. Wu YK, Lien YH, Lin KH, Shih TF, Wang TG, Wang HKJSjom, et al. Relationships between three potentiation effects of plyometric training and performance. 2010;20(1):e80-e6.

133. Maquirriain J. Leg stiffness changes in athletes with Achilles tendinopathy. Int J Sports Med. 2012;33(7):567-71.

134. Flanagan EP, Galvin L, Harrison AJ. Force production and reactive strength capabilities after anterior cruciate ligament reconstruction. Journal of athletic training. 2008;43(3):249-57.

135. Driller MW, Overmayer RGJPTiS. The effects of tissue flossing on ankle range of motion and jump performance. 2017;25:20-4.

136. Shaffer SW, Teyhen DS, Lorenson CL, Warren RL, Koreerat CM, Straseske CA, et al. Y-Balance Test: A Reliability Study Involving Multiple Raters. Military Medicine. 2013;178(11):1264-70.

137. Plisky PJ, Rauh MJ, Kaminski TW, Underwood FBJJoo, therapy sp. Star Excursion Balance Test as a predictor of lower extremity injury in high school basketball players. 2006;36(12):911-9.

138. Smith CA, Chimera NJ, Warren M. Association of y balance test reach asymmetry and injury in division I athletes. Medicine and science in sports and exercise. 2015;47(1):136-41.

139. Hill MW, Wdowski MM, Rosicka K, Kay AD, Muehlbauer T. Exploring the relationship of static and dynamic balance with muscle mechanical properties of the lower limbs in healthy young adults. 2023;14.

140. Kaneda H, Takahira N, Tsuda K, Tozaki K, Kudo S, Takahashi Y, et al. Effects of Tissue Flossing and Dynamic Stretching on Hamstring Muscles Function. Journal of sports science & medicine. 2020;19:681-9.

141. Driller M, Overmayer R. The effects of tissue flossing on ankle range of motion and jump performance. Physical Therapy in Sport. 2016;25.

142. Maust Z, Bradney D, Collins SM, Wesley C, Bowman TGJIJoSPT. The effects of soft tissue flossing on hamstring range of motion and lower extremity power. 2021;16(3):689.

143. Secomb JL, Nimphius S, Farley OR, Lundgren LE, Tran TT, Sheppard JMJJoss, et al. Relationships between lower-body muscle structure and, lower-body strength, explosiveness and eccentric leg stiffness in adolescent athletes. 2015;14(4):691.

144. Wong JD, Bobbert MF, van Soest AJ, Gribble PL, Kistemaker DA. Optimizing the Distribution of Leg Muscles for Vertical Jumping. PloS one. 2016;11(2):e0150019.

145. Doma K, Leicht AS, Boullosa D, Woods CT. Lunge exercises with blood-flow restriction induces post-activation potentiation and improves vertical jump performance. European Journal of Applied Physiology. 2020;120(3):687-95.

146. Norris CM, Matthews M. Inter-tester reliability of a self-monitored active knee extension test. Journal of Bodywork and Movement Therapies. 2005;9(4):256-9.

147. Richman ED, Tyo BM, Nicks CR. Combined Effects of Self-Myofascial Release and Dynamic Stretching on Range of Motion, Jump, Sprint, and Agility Performance. The Journal of Strength & Conditioning Research. 2019;33(7).

148. Monteiro ER, da Silva Novaes J, Cavanaugh MT, Hoogenboom BJ, Steele J, Vingren JL, et al. Quadriceps foam rolling and rolling massage increases hip flexion and extension passive range-of-motion. Journal of Bodywork and Movement Therapies. 2019;23(3):575-80.

149. Behara B, Jacobson BH. Acute Effects of Deep Tissue Foam Rolling and Dynamic Stretching on Muscular Strength, Power, and Flexibility in Division I Linemen. Journal of strength and conditioning research. 2017;31(4):888-92.

150. Bizzini M, Mannion AF. Reliability of a new, hand-held device for assessing skeletal muscle stiffness. Clinical biomechanics (Bristol, Avon). 2003;18(5):459-61.

151. Objero CN, Wdowski MM, Hill MWJG, posture. Can arm movements improve postural stability during challenging standing balance tasks? 2019;74:71-5.

152. Gribble PA, Hertel JJMipe, science e. Considerations for normalizing measures of the Star Excursion Balance Test. 2003;7(2):89-100.

153. Cohen JJH, NJ. Statistical power analysis for the behavioral sciences. Lawrence Erlbaum Associates. 1988:20-6.

154. Richardson JTE. Eta squared and partial eta squared as measures of effect size in educational research. Educational Research Review. 2011;6(2):135-47.

155. Opplert J, Genty JB, Babault N. Do Stretch Durations Affect Muscle Mechanical and Neurophysiological Properties? Int J Sports Med. 2016;37(9):673-9.

156. Cheatham S, Martinez R, Montalvo A, Odai M, Echeverry S, Robinson B, et al. Myofascial Compression Interventions: Comparison of Roller Massage, Instrument Assisted Soft-Tissue Mobilization, and Floss Band on Passive Knee Motion Among Inexperienced Individuals. 2020;3:24-36.

157. Driller M, Mackay K, Mills B, Tavares F. Tissue flossing on ankle range of motion, jump and sprint performance: A follow-up study. Physical Therapy in Sport. 2017;28.

158. Stevenson PJ, Stevenson RK, Duarte KWJJoMB, Sciences A. Acute effects of the voodoo flossing band on ankle range of motion. 2019;7(6):244-53.

159. Ross S, Kandassamy GJJoPT. The effects of 'tack and floss' active joint mobilisation on ankle dorsiflexion range of motion using voodoo floss bands. 2017.

160. Mills B, Mayo B, Tavares F, Driller M. The Effect of Tissue Flossing on Ankle Range of Motion, Jump and Sprint Performance in Elite Rugby Union Athletes. Journal of Sport Rehabilitation. 2019;29:1-18.

161. Kaneda H, Takahira N, Tsuda K, Tozaki K, Sakai K, Kudo S, et al. The effects of tissue flossing and static stretching on gastrocnemius exertion and flexibility. Isokinetics and Exercise Science. 2020;28:205-13.

162. Vogrin M, Novak F, Ličen T, Greiner N, Mikl S, Kalc M. Acute Effects of Tissue Flossing on Ankle Range of Motion and Tensiomyography Parameters. Journal of Sport Rehabilitation. 2020;30:1-7.

163. Pavlů D, Pánek D, Kuncová E, Seng T. Effect of Blood Circulation in the Upper Limb after Flossing Strategy. Applied Sciences. 2021;11:1634.

164. Wilk M, Krzysztofik M, Jarosz J, Krol P, Leznicka K, Zajac A, et al. Impact of Ischemic Intra-Conditioning on Power Output and Bar Velocity of the Upper Limbs. Front Physiol. 2021;12:626915.

165. Konrad A, Bernsteiner D, Budini F, Reiner MM, Glashüttner C, Berger C, et al. Tissue flossing of the thigh increases isometric strength acutely but has no effects on flexibility or jump height. European Journal of Sport Science. 2020:1-11.

166. Maffiuletti NA, Aagaard P, Blazevich AJ, Folland J, Tillin N, Duchateau J. Rate of force development: physiological and methodological considerations. Eur J Appl Physiol. 2016;116(6):1091-116.

167. Moon B-H, Kim J-W. Effects of Floss Bands on Ankle Joint Range of Motion and Balance Ability. Physical Therapy Korea. 2022;29(4):274-81.

168. Chang N-J, Hung W-C, Lee C-L, Chang W-D, Wu B-H. Effects of a Single Session of Floss Band Intervention on Flexibility of Thigh, Knee Joint Proprioception, Muscle Force Output, and Dynamic Balance in Young Adults. 2021;11(24):12052.

169. Nelson S, Wilson CS, Becker J. Kinematic and Kinetic Predictors of Y-Balance Test Performance. Int J Sports Phys Ther. 2021;16(2):371-80.

170. Nakagawa TH, Petersen RS. Relationship of hip and ankle range of motion, trunk muscle endurance with knee valgus and dynamic balance in males. Physical therapy in sport : official journal of the Association of Chartered Physiotherapists in Sports Medicine. 2018;34:174-9.

171. Galis J, Cooper D. Application of a Floss Band at Differing Pressure Levels: Effects at the Ankle Joint. The Journal of Strength and Conditioning Research. 2020.

172. Fatela P, Reis JF, Mendonca GV, Avela J, Mil-Homens P. Acute effects of exercise under different levels of blood-flow restriction on muscle activation and fatigue. European Journal of Applied Physiology. 2016;116(5):985-95.

173. Su H, Chang N-J, Wu W-L, Guo L-Y, Chu IH. Acute Effects of Foam Rolling, Static Stretching, and Dynamic Stretching During Warm-ups on Muscular Flexibility and Strength in Young Adults. Journal of Sport Rehabilitation. 2017;26(6):469-77.

174. Barnes MFJJob, therapies m. The basic science of myofascial release: morphologic change in connective tissue. 1997;1(4):231-8.

175. Mayer I, Hoppe MW, Freiwald J, Heiss R, Engelhardt M, Grim C, et al. Different Effects of Foam Rolling on Passive Tissue Stiffness in Experienced and Nonexperienced Athletes. J Sport Rehabil. 2020;29(7):926-33.

176. Gervasi M, Benelli P, Venerandi R, Fernández-Peña E. Relationship between Muscle-Tendon Stiffness and Drop Jump Performance in Young Male Basketball Players during Developmental Stages. Int J Environ Res Public Health. 2022;19(24).

177. Fama BJ, Bueti DR. The acute effect of self-myofascial release on lower extremity plyometric performance. 2011.

178. Cooper CN, Dabbs NC, Davis J, Sauls NM. Effects of Lower-Body Muscular Fatigue on Vertical Jump and Balance Performance. Journal of strength and conditioning research. 2020;34(10):2903-10.

179. Wiewelhove T, Döweling A, Schneider C, Hottenrott L, Meyer T, Kellmann M, et al. A Meta-Analysis of the Effects of Foam Rolling on Performance and Recovery. 2019;10.

180. Byrne C, Twist C, Eston R. Neuromuscular Function After Exercise-Induced Muscle Damage. Sports Medicine. 2004;34(1):49-69.

12. List of figures, graphs, and tables

Fig. 18 Bar chart showing ROM results. pre -purple bar; green – post1, yellow – post2. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning, R right leg, L left leg

Fig. 19 The mean ± standard error (SE) values for muscle tone [Hz] of the VL left leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Fig. 20 The mean ± standard error (SE) values for stiffness [N/m] of the VL left leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Fig. 21 The mean ± standard error (SE) values for muscle tone [Hz] of the VL right leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Fig. 22 The mean ± standard error (SE) values for stiffness [N/m] of the VL right leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Fig. 23 The mean ± standard error (SE) values for muscle tone [Hz] of the RF left leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Fig. 24 The mean ± standard error (SE) values for stiffness [N/m] of the RF left leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Fig. 25 The mean ± standard error (SE) values for muscle tone [Hz] of the RF right leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Fig. 26 The mean ± standard error (SE) values for stiffness [N/m] of the RF right leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Fig. 27 The mean ± standard error (SE) values for muscle tone [Hz] of the BF left leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Fig. 28 The mean ± standard error (SE) values for stiffness [N/m] of the BF left leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Fig. 29 The mean ± standard error (SE) values for muscle tone [Hz] of the BF right leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Fig. 30 The mean ± standard error (SE) values for stiffness [N/m] of the BF right leg for both pre and post measurements. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Fig 31. The mean ± standard error (SE) values for Jump Height [m]. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Fig. 32 The mean ± standard error (SE) values for Braking Rate of Force Development (RFD) [m/s]. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Fig. 33 The mean ± standard error (SE) values for Composite Score [%] of Y balance test for right leg. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Fig. 34 The mean ± standard error (SE) values for Composite Score [%] of Y balance test for left leg. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Fig. 35 Bar chart showing Y-balance composite score results. pre -purple bar; green – post1, yellow – post2. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Table 1. Classifications and definitions of lower extremity stiffness

Table 2. Descriptive statistic of subjects. SD- standard deviation, Min- minimal value, Max- maximum value, BF -Body Fat.

Table 3 The mean ± standard deviation (SD) values for the range of motion (ROM). CON- Control condition, FLOSS- tissue flossing condition, FR- foam rolling condition

Table 4 Positive, negative and no-responses to the interventions for knee range of motion. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning.

Table 5 The mean ± standard deviation (SD) values for muscle tone [Hz]. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning, Bic Fem c l - Biceps Femoris Caput longum, Rect – Rectus, Vastus lt- Vastus Lateralis

Table 6 The mean ± standard deviation (SD) values for stiffness [N/m]. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning, Bic Fem c l - Biceps Femoris Caput longum, Rect – Rectus, Vastus lt- Vastus Lateralis

Table 7 Positive, negative and no-responses to the interventions for muscle tone [Hz]. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning, Bic Fem c l -Biceps Femoris Caput longum

Table 8 Positive, negative and no-responses to the interventions for muscle stiffness [N/m]. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning, Bic Fem c l -Biceps Femoris Caput longum

Table 9 The mean ± standard deviation (SD) values for Braking Rate of Force Development [N/s] and jump height [m]. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Table 10 Positive, negative and no-responses to the interventions for muscle tone [Hz]. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning, RFD- Rate of Force Development.

Table 11 The mean ± standard deviation (SD) values for Composite Score [%] of Y balance test. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning

Table 12 Positive, negative and no-responses to the interventions for Y- balance test. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning.

13. Attachments

List of the attachments:

Annex 1. Ethical Commission Approval

Annex 2. ROM results

Annex 3. Y-balance composite score results

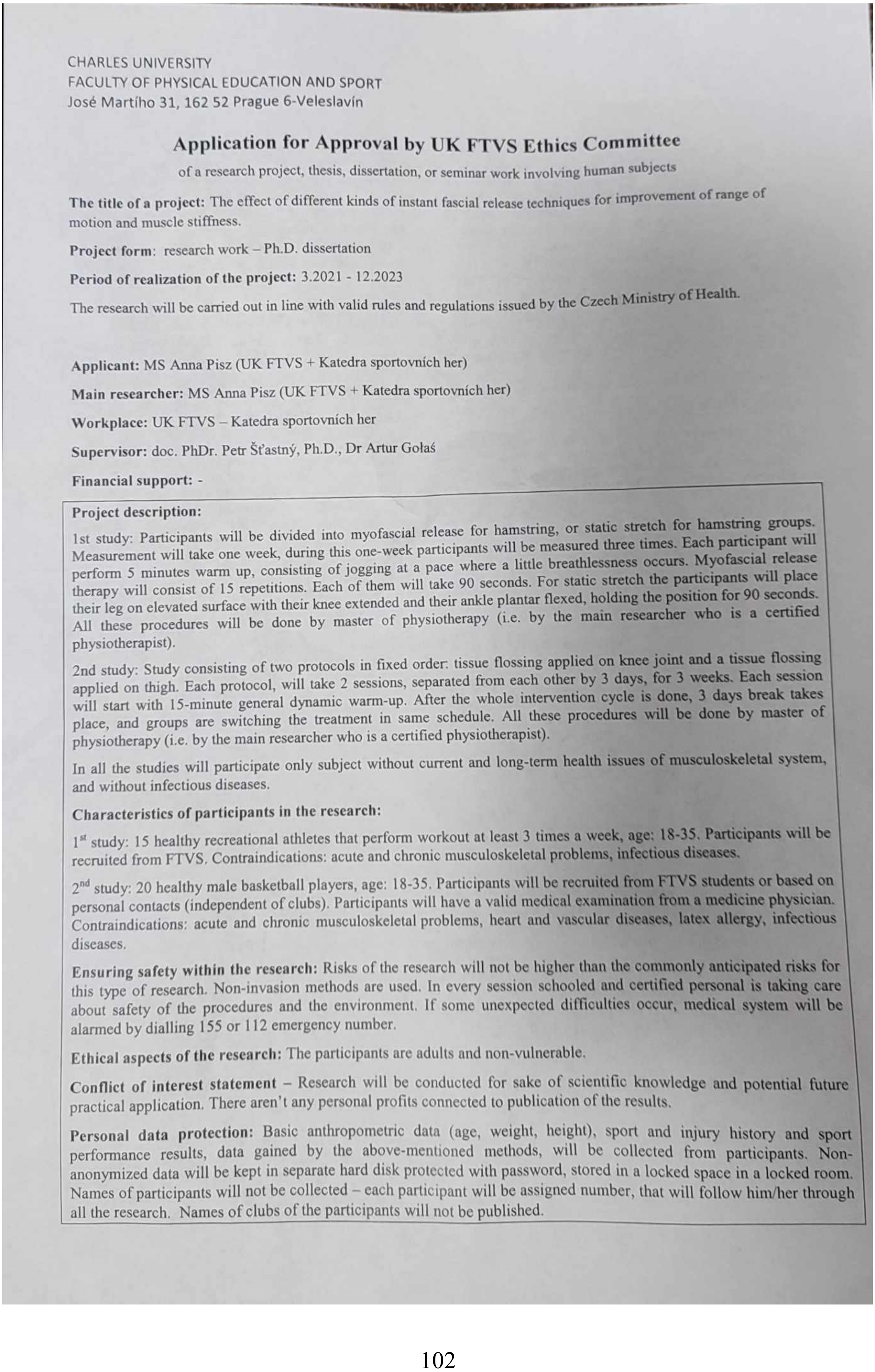
Annex 4. Jump height values

Annex 5. Jump BrakingRFD values.

Annex 6. Muscle frequency [Hz]

Annex 7. Muscle stiffness [N/m]

Annex 1. Ethical Commission Approval



CHARLES UNIVERSITY
FACULTY OF PHYSICAL EDUCATION AND SPORT
José Martího 31, 162 52 Prague 6-Veleslavín

Application for Approval by UK FTVS Ethics Committee

of a research project, thesis, dissertation, or seminar work involving human subjects

The title of a project: The effect of different kinds of instant fascial release techniques for improvement of range of motion and muscle stiffness.

Project form: research work – Ph.D. dissertation

Period of realization of the project: 3.2021 - 12.2023

The research will be carried out in line with valid rules and regulations issued by the Czech Ministry of Health.

Applicant: MS Anna Pisz (UK FTVS + Katedra sportovních her)

Main researcher: MS Anna Pisz (UK FTVS + Katedra sportovních her)

Workplace: UK FTVS – Katedra sportovních her

Supervisor: doc. PhDr. Petr Šťastný, Ph.D., Dr Artur Gołaś

Financial support: -

Project description:

1st study: Participants will be divided into myofascial release for hamstring, or static stretch for hamstring groups. Measurement will take one week, during this one-week participants will be measured three times. Each participant will perform 5 minutes warm up, consisting of jogging at a pace where a little breathlessness occurs. Myofascial release therapy will consist of 15 repetitions. Each of them will take 90 seconds. For static stretch the participants will place their leg on elevated surface with their knee extended and their ankle plantar flexed, holding the position for 90 seconds. All these procedures will be done by master of physiotherapy (i.e. by the main researcher who is a certified physiotherapist).

2nd study: Study consisting of two protocols in fixed order: tissue flossing applied on knee joint and a tissue flossing applied on thigh. Each protocol, will take 2 sessions, separated from each other by 3 days, for 3 weeks. Each session will start with 15-minute general dynamic warm-up. After the whole intervention cycle is done, 3 days break takes place, and groups are switching the treatment in same schedule. All these procedures will be done by master of physiotherapy (i.e. by the main researcher who is a certified physiotherapist).

In all the studies will participate only subject without current and long-term health issues of musculoskeletal system, and without infectious diseases.

Characteristics of participants in the research:

1st study: 15 healthy recreational athletes that perform workout at least 3 times a week, age: 18-35. Participants will be recruited from FTVS. Contraindications: acute and chronic musculoskeletal problems, infectious diseases.

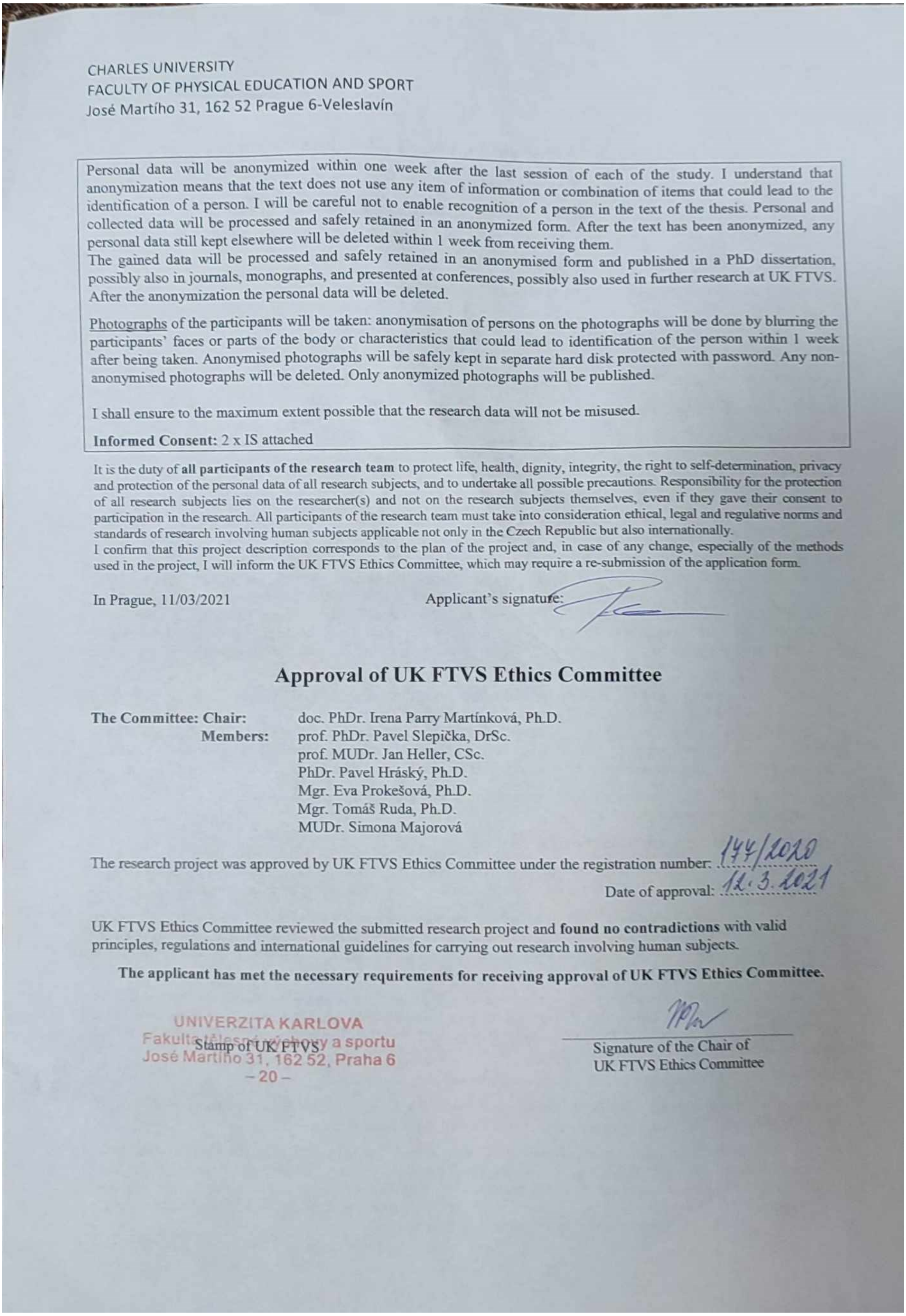
2nd study: 20 healthy male basketball players, age: 18-35. Participants will be recruited from FTVS students or based on personal contacts (independent of clubs). Participants will have a valid medical examination from a medicine physician. Contraindications: acute and chronic musculoskeletal problems, heart and vascular diseases, latex allergy, infectious diseases.

Ensuring safety within the research: Risks of the research will not be higher than the commonly anticipated risks for this type of research. Non-invasion methods are used. In every session schooled and certified personal is taking care about safety of the procedures and the environment. If some unexpected difficulties occur, medical system will be alarmed by dialling 155 or 112 emergency number.

Ethical aspects of the research: The participants are adults and non-vulnerable.

Conflict of interest statement – Research will be conducted for sake of scientific knowledge and potential future practical application. There aren't any personal profits connected to publication of the results.

Personal data protection: Basic anthropometric data (age, weight, height), sport and injury history and sport performance results, data gained by the above-mentioned methods, will be collected from participants. Non-anonymized data will be kept in separate hard disk protected with password, stored in a locked space in a locked room. Names of participants will not be collected – each participant will be assigned number, that will follow him/her through all the research. Names of clubs of the participants will not be published.



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Personal data will be anonymized within one week after the last session of each of the study. I understand that anonymization means that the text does not use any item of information or combination of items that could lead to the identification of a person. I will be careful not to enable recognition of a person in the text of the thesis. Personal and collected data will be processed and safely retained in an anonymized form. After the text has been anonymized, any personal data still kept elsewhere will be deleted within 1 week from receiving them.
The gained data will be processed and safely retained in an anonymised form and published in a PhD dissertation, possibly also in journals, monographs, and presented at conferences, possibly also used in further research at UK FTVS. After the anonymization the personal data will be deleted.

Photographs of the participants will be taken: anonymisation of persons on the photographs will be done by blurring the participants' faces or parts of the body or characteristics that could lead to identification of the person within 1 week after being taken. Anonymised photographs will be safely kept in separate hard disk protected with password. Any non-anonymised photographs will be deleted. Only anonymized photographs will be published.

I shall ensure to the maximum extent possible that the research data will not be misused.

Informed Consent: 2 x IS attached

It is the duty of **all participants of the research team** to protect life, health, dignity, integrity, the right to self-determination, privacy and protection of the personal data of all research subjects, and to undertake all possible precautions. Responsibility for the protection of all research subjects lies on the researcher(s) and not on the research subjects themselves, even if they gave their consent to participation in the research. All participants of the research team must take into consideration ethical, legal and regulative norms and standards of research involving human subjects applicable not only in the Czech Republic but also internationally.
I confirm that this project description corresponds to the plan of the project and, in case of any change, especially of the methods used in the project, I will inform the UK FTVS Ethics Committee, which may require a re-submission of the application form.

In Prague, 11/03/2021 Applicant's signature:

Approval of UK FTVS Ethics Committee

The Committee: Chair: doc. PhDr. Irena Parry Martínková, Ph.D.
Members: prof. PhDr. Pavel Slepička, DrSc.
prof. MUDr. Jan Heller, CSc.
PhDr. Pavel Hráský, Ph.D.
Mgr. Eva Prokešová, Ph.D.
Mgr. Tomáš Ruda, Ph.D.
MUDr. Simona Majorová

The research project was approved by UK FTVS Ethics Committee under the registration number: 144/2020

Date of approval: 12. 3. 2021

UK FTVS Ethics Committee reviewed the submitted research project and **found no contradictions** with valid principles, regulations and international guidelines for carrying out research involving human subjects.

The applicant has met the necessary requirements for receiving approval of UK FTVS Ethics Committee.

UNIVERZITA KARLOVA
Fakulta tělesné výchovy a sportu
José Martího 31, 162 52, Praha 6
– 20 –

Stamp of UK FTVS

Signature of the Chair of
UK FTVS Ethics Committee

Annex 2. ROM results. CON -control conditioning, FLOSS- Tissue flossing conditioning, FR- foam rolling conditioning, R- right, L- left, max- maximum value.

Intervention	Pre_R	Pre_L	Post1_R	Post1_L	Post2_R	Post2_L	R max	L max
CON	67	65	67	64	70	67	70	67
CON	76	70	65	64	71	65	71	65
CON	74	77	74	77	78	74	78	77
CON	50	48	62	60	50	45	62	60
CON	86	87	87	88	87	87	87	88
CON	48	40	48	40	42	36	48	40
CON	56	50	51	50	54	48	54	50
CON	74	75	70	69	66	63	70	69
CON	69	71	69	67	71	70	71	70
CON	79	84	82	83	81	84	82	84
CON	59	61	56	51	56	54	56	54
CON	75	80	81	77	75	73	81	77
CON	65	73	64	67	71	66	71	67
CON	69	61	54	49	62	59	62	59
CON	68	50	63	61	56	52	63	61
CON	67	62	64	62	76	66	76	66
CON	72	68	68	72	69	74	69	74
CON	52	52	52	45	44	37	52	45
CON	57	50	51	52	50	51	51	52
CON	51	56	50	56	54	57	54	57
CON	60	63	64	62	66	68	66	68
CON	74	72	74	71	74	75	74	75
CON	57	50	62	60	66	65	66	65
CON	72	78	79	77	79	78	79	78
CON	79	83	80	84	79	82	80	84
CON	61	64	66	65	72	76	72	76
CON	56	56	57	55	55	57	57	57
CON	55	54	52	56	48	51	52	56
CON	55	50	50	45	47	42	50	45
CON	53	54	59	56	63	60	63	60
FLOSS	61	60	64	66	68	66	68	66
FLOSS	64	63	72	75	71	72	72	75
FLOSS	67	75	76	76	70	75	76	76
FLOSS	74	66	74	72	75	70	75	72
FLOSS	62	61	71	66	77	70	77	70
FLOSS	30	32	40	36	40	44	40	44
FLOSS	55	50	66	56	62	58	66	58
FLOSS	66	64	86	79	78	72	86	79
FLOSS	62	63	70	69	69	69	70	69
FLOSS	80	74	81	81	80	83	81	83
FLOSS	47	46	55	54	56	59	56	59

FLOSS	75	71	84	86	82	83	84	86
FLOSS	74	76	76	74	75	73	76	74
FLOSS	72	74	75	79	76	71	76	79
FLOSS	66	55	66	61	64	61	66	61
FLOSS	64	63	60	60	71	65	71	65
FLOSS	57	59	65	65	69	70	69	70
FLOSS	55	47	45	49	41	40	45	49
FLOSS	40	42	50	51	48	43	50	51
FLOSS	64	60	64	59	65	60	65	60
FLOSS	46	47	49	51	60	58	60	58
FLOSS	64	69	72	71	68	71	72	71
FLOSS	66	67	76	81	73	70	76	81
FLOSS	46	48	55	56	54	57	55	57
FLOSS	66	61	69	67	71	76	71	76
FLOSS	57	65	67	71	68	74	68	74
FLOSS	54	53	60	60	61	60	61	60
FLOSS	57	55	54	56	58	50	58	56
FLOSS	55	49	56	50	60	53	60	53
FLOSS	65	63	67	64	59	59	67	64
FR	71	74	76	74	77	75	77	75
FR	58	54	63	66	69	66	69	66
FR	66	63	63	61	60	63	63	63
FR	79	77	72	76	75	74	75	76
FR	74	79	80	82	80	81	80	82
FR	51	45	53	45	53	48	53	48
FR	56	56	58	55	54	52	58	55
FR	74	69	75	77	73	73	75	77
FR	64	67	67	70	68	70	68	70
FR	66	69	80	75	70	69	80	75
FR	55	53	60	58	58	58	60	58
FR	75	79	80	84	84	80	84	84
FR	67	71	74	75	70	67	74	75
FR	55	56	65	64	63	59	65	64
FR	56	50	53	55	57	58	57	58
FR	65	66	65	61	66	63	66	63
FR	63	66	65	69	58	70	65	70
FR	40	42	41	42	44	36	44	42
FR	51	51	50	50	41	43	50	50
FR	41	43	50	45	55	57	55	57
FR	66	70	71	78	71	78	71	78
FR	61	56	59	61	60	59	60	61
FR	67	66	66	67	63	62	66	67
FR	45	51	47	53	61	56	61	56
FR	64	65	66	76	70	71	70	76
FR	67	74	66	73	61	55	66	73
FR	53	57	70	75	76	73	76	75
FR	50	54	60	59	54	59	60	59

FR	50	49	60	55	59	54	60	55
FR	71	61	67	59	61	63	67	63

Annex 3. Y-balance composite score. CON -control conditioning, FLOSS- Tissue flossing conditioning, FR- foam rolling conditioning, R- right, L- left, max- maximum value.

Conditioning	R Composite score PRE	L Composite score PRE	R Composite score POST1	L Composite score POST1	R Composite score POST2	L Composite score POST2
CON	80.25	80.26	85.39	75.82	83.68	83.67
CON	88.59	91.21	88.96	93.77	92.65	92.67
CON	83.42	84.25	82.75	83.92	83.08	82.25
CON	72.10	108.09	70.81	105.50	74.68	105.83
CON	85.14	91.48	88.93	92.53	88.25	93.94
CON	81.11	84.13	80.47	85.72	81.42	83.81
CON	85.14	85.41	83.42	81.95	79.30	83.33
CON	85.30	83.65	82.78	84.59	85.30	83.96
CON	91.41	93.75	90.38	93.40	92.10	94.10
CON	90.13	91.19	88.87	90.57	88.24	90.88
CON	86.25	85.32	86.25	86.01	87.29	86.36
CON	90.68	93.96	91.04	92.53	91.04	93.60
CON	91.40	93.60	94.62	91.82	93.91	95.75
CON	79.03	113.69	77.53	117.37	79.40	109.64
CON	89.32	87.60	83.17	84.70	89.97	89.53
CON	87.92	87.65	91.65	87.65	89.27	87.99
CON	92.88	93.82	93.20	93.18	92.56	94.14
CON	91.26	95.19	90.94	94.87	90.94	94.87
CON	84.18	88.32	81.81	89.00	81.47	92.05
CON	84.96	92.33	83.88	89.42	88.58	93.06
CON	83.60	86.41	85.41	87.13	86.85	88.21
CON	92.87	89.86	90.60	89.11	90.98	89.86
CON	64.98	100.34	62.96	99.33	63.30	96.97
CON	87.72	85.76	89.82	88.19	89.82	87.15
CON	97.12	95.29	94.39	91.67	93.68	91.32
CON	88.59	89.49	92.37	94.57	96.39	94.57
CON	80.59	90.18	89.64	89.14	87.89	89.49
CON	90.59	90.32	91.55	91.94	90.59	91.29
CON	89.72	85.52	87.23	80.27	83.69	82.72
CON	80.27	104.47	78.51	102.73	76.76	107.27
FLOSS	71.33	92.90	74.76	110.66	65.50	88.80
FLOSS	87.36	88.56	91.23	92.22	90.32	91.41
FLOSS	83.42	82.92	82.42	85.25	85.08	85.25
FLOSS	88.91	89.64	89.88	92.23	94.08	91.26
FLOSS	66.87	96.74	72.73	108.31	71.70	104.80
FLOSS	76.34	85.09	82.38	84.13	82.38	84.77
FLOSS	85.82	81.95	84.79	80.57	84.11	82.30

FLOSS	82.47	83.02	85.93	87.09	84.67	84.90
FLOSS	90.72	94.79	91.41	94.10	91.75	94.10
FLOSS	88.87	92.45	89.50	91.82	89.82	89.62
FLOSS	85.91	86.01	88.66	84.28	89.69	87.05
FLOSS	92.11	94.68	91.76	91.46	92.11	92.18
FLOSS	93.19	95.75	94.27	95.03	94.27	95.03
FLOSS	96.63	89.40	95.88	87.93	100.00	91.98
FLOSS	93.53	89.53	89.32	88.89	89.32	88.89
FLOSS	91.31	83.59	85.20	82.91	85.20	82.91
FLOSS	86.73	95.42	93.53	92.54	97.73	92.54
FLOSS	89.98	92.31	88.70	93.27	89.98	89.10
FLOSS	71.28	98.14	68.23	100.51	68.57	101.52
FLOSS	91.11	90.88	90.74	95.24	93.28	93.42
FLOSS	81.08	82.07	83.60	83.88	84.68	85.32
FLOSS	92.87	90.60	91.36	89.86	93.62	89.86
FLOSS	79.46	83.50	81.82	81.14	81.48	83.84
FLOSS	88.77	84.72	87.72	85.76	89.12	88.19
FLOSS	95.29	95.65	185.96	93.06	91.93	92.71
FLOSS	84.38	81.86	89.45	90.22	89.81	92.39
FLOSS	64.15	95.84	68.28	105.79	68.98	104.41
FLOSS	78.66	110.14	73.82	103.31	70.60	103.31
FLOSS	93.26	90.43	90.07	92.18	90.07	92.18
FLOSS	90.78	91.19	93.94	91.19	89.03	90.50
FR	87.11	83.33	84.36	82.31	84.02	84.70
FR	87.86	89.01	91.55	86.81	91.18	88.28
FR	68.46	98.24	68.13	100.57	67.13	101.57
FR	97.96	95.79	97.32	95.47	95.70	95.15
FR	87.21	87.63	87.56	92.18	87.90	92.53
FR	81.42	81.26	77.61	83.81	81.11	85.72
FR	67.28	94.05	69.00	91.63	67.97	96.82
FR	83.73	87.72	86.56	85.84	84.67	89.29
FR	89.35	90.28	90.38	92.01	91.75	109.38
FR	76.22	105.66	76.22	101.89	75.59	105.66
FR	88.66	92.57	89.35	90.50	87.29	85.66
FR	93.55	91.82	93.55	94.68	93.55	94.68
FR	95.34	95.03	92.11	105.04	93.91	98.25
FR	94.76	86.09	93.63	85.36	95.88	90.14
FR	92.88	90.82	83.50	87.92	83.50	89.53
FR	90.97	84.94	89.27	87.31	90.63	89.68
FR	94.17	94.46	90.94	94.78	90.94	94.78
FR	89.34	93.91	93.18	91.99	88.06	92.95
FR	82.15	84.26	82.82	85.96	80.79	85.96
FR	86.77	89.06	86.04	91.24	87.13	90.51
FR	85.41	87.13	88.29	90.74	88.65	91.83
FR	83.81	91.93	83.43	118.20	82.67	114.84

FR	80.81	82.83	82.15	83.84	81.82	85.52
FR	73.33	106.60	76.49	112.50	72.63	112.85
FR	94.56	94.57	91.23	90.63	93.33	90.97
FR	91.04	89.14	93.10	96.01	93.10	96.01
FR	87.54	90.53	88.24	89.14	87.89	89.49
FR	86.72	89.67	88.33	89.99	92.20	91.29
FR	89.36	86.58	90.07	86.93	90.78	91.13
FR	90.43	91.54	93.24	90.50	92.88	92.59

Annex 3. Jump height values. CON -control conditioning, FLO- Tissue flossing conditioning, FR- foam rolling conditioning.

Intervention	JumpHeight_Post1_MAX	JumpHeight_Post2_MAX	JumpHeight_Pre_MAX	Post_max
CON	0.31	0.31	0.32	0.31
CON	0.31	0.32	0.32	0.32
CON	0.4	0.38	0.4	0.4
CON	0.46	0.47	0.46	0.47
CON	0.4	0.4	0.4	0.4
CON	0.24	0.25	0.28	0.25
CON	0.33	0.3	0.33	0.33
CON	0.34	0.33	0.32	0.34
CON	0.34	0.3	0.35	0.34
CON	0.41	0.38	0.43	0.41
CON	0.32	0.31	0.27	0.32
CON	0.4	0.38	0.38	0.4
CON	0.35	0.35	0.35	0.35
CON	0.34	0.33	0.36	0.34
CON	0.34	0.34	0.34	0.34
CON	0.37	0.37	0.37	0.37
CON	0.5	0.47	0.51	0.5
CON	0.43	0.4	0.43	0.43
CON	0.29	0.28	0.3	0.29
CON	0.38	0.37	0.38	0.38
CON	0.39	0.39	0.41	0.39
CON	0.37	0.34	0.36	0.37
CON	0.28	0.54	0.28	0.54
CON	0.36	0.34	0.37	0.36
CON	0.28	0.28	0.28	0.28
CON	0.39	0.38	0.39	0.39
CON	0.33	0.3	0.33	0.33
CON	0.3	0.28	0.31	0.3
CON	0.31	0.29	0.31	0.31
CON	0.42	0.41	0.41	0.42
FLO	0.32	0.29	0.33	0.32
FLO	0.39	0.37	0.41	0.39
FLO	0.48	0.47	0.47	0.48
FLO	0.41	0.39	0.41	0.41
FLO	0.25	0.26	0.25	0.26
FLO	0.32	0.31	0.32	0.32
FLO	0.31	0.32	0.34	0.32
FLO	0.34	0.31	0.36	0.34

FLO	0.3	0.3	0.29	0.3
FLO	0.34	0.33	0.32	0.34
FLO	0.37	0.36	0.38	0.37
FLO	0.34	0.33	0.32	0.34
FLO	0.34	0.34	0.34	0.34
FLO	0.36	0.34	0.35	0.36
FLO	0.37	0.34	0.37	0.37
FLO	0.45	0.46	0.51	0.46
FLO	0.4	0.39	0.4	0.4
FLO	0.3	0.28	0.31	0.3
FLO	0.37	0.38	0	0.38
FLO	0.35	0.36	0.38	0.36
FLO	0.38	0.35	0.39	0.38
FLO	0.28	0.26	0.28	0.28
FLO	0.34	0.32	0.35	0.34
FLO	0.29	0.29	0.29	0.29
FLO	0.41	0.39	0.42	0.41
FLO	0.41	0.39	0.42	0.41
FLO	0.29	0.3	0.3	0.3
FLO	0.29	0.3	0.3	0.3
FLO	0.3	0.28	0.3	0.3
FLO	0.46	0.43	0.44	0.46
FR	0.32	0.31	0.3	0.32
FR	0.3	0.29	0.32	0.3
FR	0.38	0.39	0.4	0.39
FR	0.42	0.43	0.43	0.43
FR	0.4	0.36	0.37	0.4
FR	0.23	0.24	0.25	0.24
FR	0.33	0.31	0.32	0.33
FR	0.36	0.35	0.37	0.36
FR	0.33	0.32	0.37	0.33
FR	0.4	0.38	0.42	0.4
FR	0.3	0.3	0.31	0.3
FR	0.36	0.35	0.39	0.36
FR	0.33	0.32	0.35	0.33
FR	0.35	0.34	0.35	0.35
FR	0.34	0.34	0.34	0.34
FR	0.36	0.35	0.37	0.36
FR	0.46	0.45	0.47	0.46
FR	0.39	0.38	0.41	0.39
FR	0.29	0.28	0.29	0.29
FR	0.37	0.35	0.77	0.37
FR	0.4	0.38	0.37	0.4
FR	0.34	0.31	0.38	0.34
FR	0.28	0.26	0.27	0.28

FR	0.33	0.34	0.35	0.34
FR	0.3	0.29	0.29	0.3
FR	0.39	0.39	0.4	0.39
FR	0.28	0.28	0.28	0.28
FR	0.35	0.3	0.32	0.35
FR	0.3	0.29	0.29	0.3
FR	0.42	0.4	0.45	0.42

Annex 5. Jump BrakingRFD values. CON -control conditioning, FLO- Tissue flossing conditioning, FR- foam rolling conditioning.

Conditioning	BrakingRFD_Post1_MAX	BrakingRFD_Post2_MAX	BrakingRFD_Pre_MAX	Post_max
CON	3930.23	3404.26	4619.29	3930.23
CON	3968.75	4106.92	5401.52	4106.92
CON	7333.33	8610.47	5407.04	8610.47
CON	7727.85	6016.95	5572.82	7727.85
CON	9372.09	8911.76	4132.28	9372.09
CON	3471.43	5192.98	6019.74	5192.98
CON	9564.1	6352.33	8518.52	9564.1
CON	4770.11	4724.32	6178.08	4770.11
CON	3439.61	4627.22	4757.89	4627.22
CON	6373.49	5776.54	7935.06	6373.49
CON	7373.45	8372.91	4005.29	8372.91
CON	10237.29	8141.46	7634.41	10237.29
CON	4634.92	4688.52	5218.39	4688.52
CON	3582.64	3967.44	3508.33	3967.44
CON	4281.44	5500	5352.2	5500
CON	826.39	1033.16	1254.42	1033.16
CON	7739.39	6757.06	7478.53	7739.39
CON	8668.97	8217.11	9615.94	8668.97
CON	6357.58	6670.97	6395.06	6670.97
CON	6863.64	6211.18	7121.79	6863.64
CON	5940.12	3873.68	5409.36	5940.12
CON	2678.9	2376.38	3422.02	2678.9
CON	1977.44	3585.27	1848.48	3585.27
CON	8479.17	8753.73	9555.56	8753.73
CON	12434.43	12434.43	22333.33	12434.43
CON	4989.19	5522.73	4344.83	5522.73
CON	5108.43	5777.78	4184.78	5777.78
CON	5539.57	4426.83	4104.29	5539.57
CON	4363.13	2873.36	4149.43	4363.13
CON	3960	5340.1	3881.58	5340.1
FLO	5025.25	5556.76	5846.99	5556.76
FLO	8204.82	8455.13	8865.03	8455.13
FLO	4248.96	4579.65	3878.64	4579.65
FLO	10615.38	8757.81	6523.18	10615.38
FLO	4730.16	6868.97	5858.02	6868.97
FLO	6796.79	7264.71	7908.54	7264.71
FLO	4654.05	4936.78	7021.9	4936.78
FLO	5572.29	5346.15	4745.86	5572.29

FLO	2715.64	4813.56	2859.3	4813.56
FLO	3519.42	4073.68	2903.67	4073.68
FLO	7213.93	7920.79	8785.71	7920.79
FLO	3519.42	4073.68	2903.67	4073.68
FLO	6861.64	5813.56	3871.68	6861.64
FLO	4624.31	5420.12	4600	5420.12
FLO	6294.87	3268.09	4041.67	6294.87
FLO	6954.29	6153.44	6832.37	6954.29
FLO	5895.6	7673.47	6431.14	7673.47
FLO	5694.12	6446.54	6071.43	6446.54
FLO	8162.16	9268.12	0	9268.12
FLO	3760	3364.93	2605.04	3760
FLO	2520.15	2602.32	2235.92	2602.32
FLO	1476.35	1596.61	1736.22	1596.61
FLO	8033.33	6639.24	7671.14	8033.33
FLO	12413.79	10182.54	11925	12413.79
FLO	8661.87	7376.62	6295.6	8661.87
FLO	7012.2	7219.35	7075.47	7219.35
FLO	2853.26	4713.38	3579.55	4713.38
FLO	2853.26	4713.38	3579.55	4713.38
FLO	4162.79	4973.12	3947.62	4973.12
FLO	7023.81	7220.34	5857.89	7220.34
FR	4547.62	4169.64	3730.94	4547.62
FR	5296.05	4629.14	5000	5296.05
FR	6264.71	9022.99	7477.27	9022.99
FR	5038.89	5709.3	3492.75	5709.3
FR	4319.53	3793.65	4272.19	4319.53
FR	5184.52	4963.41	4730.99	5184.52
FR	7897.14	9689.19	6085.56	9689.19
FR	4732.98	4314.43	5088.4	4732.98
FR	3837.7	4020.51	13865.98	4020.51
FR	6154.29	6306.82	6818.18	6306.82
FR	4217.39	4557.79	4842.64	4557.79
FR	7490.1	8956.04	8058.51	8956.04
FR	2572.55	2731.28	3571.43	2731.28
FR	5845.71	5556.18	5770.11	5845.71
FR	5080	5279.76	6158.23	5279.76
FR	2074.91	4437.5	964.71	4437.5
FR	5968.91	6220.43	5367.65	6220.43
FR	8098.04	7954.84	7876.62	8098.04
FR	6532.05	8230.22	5863.91	8230.22
FR	7472.97	9347.83	15392.02	9347.83
FR	4931.82	4542.37	5086.71	4931.82
FR	4179.35	3409.09	3379.81	4179.35
FR	2019.46	1919.23	1537.63	2019.46
FR	7202.61	6345.45	6440.25	7202.61
FR	22517.65	15396.23	14990.38	22517.65

FR	5670.97	5766.87	6018.63	5766.87
FR	2043.29	2114.58	2362.75	2114.58
FR	4335.23	3004.67	4559.52	4335.23
FR	4851.19	4670.21	5700.6	4851.19
FR	6447.51	8420.45	7035.93	8420.45

Annex 6. Muscle frequency [Hz]. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning, Bic Fem c l -Biceps Femoris Caput longum, Rect – Rectus, Vastus lt- Vastus Lateralis

Conditioning	Object	Side	Frequency_Post1	Frequency_Post2	Frequency_Pre
CON	Bic Fem c l	Left	14.40	13.50	18.40
CON	Bic Fem c l	Left	17.60	17.00	17.50
CON	Bic Fem c l	Left	16.50	16.80	16.80
CON	Bic Fem c l	Left	17.10	16.80	16.90
CON	Bic Fem c l	Left	15.50	15.90	16.00
CON	Bic Fem c l	Left	13.20	13.30	13.70
CON	Bic Fem c l	Left	17.00	17.20	16.40
CON	Bic Fem c l	Left	17.90	18.60	18.20
CON	Bic Fem c l	Left	13.60	13.20	13.60
CON	Bic Fem c l	Left	17.60	17.40	16.90
CON	Bic Fem c l	Left	18.50	18.60	18.30
CON	Bic Fem c l	Left	18.00	17.90	17.70
CON	Bic Fem c l	Left	18.90	17.00	17.50
CON	Bic Fem c l	Left	16.80	17.50	17.10
CON	Bic Fem c l	Left	15.90	16.30	16.40
CON	Bic Fem c l	Left	13.60	13.00	13.50
CON	Bic Fem c l	Left	16.80	16.20	16.40
CON	Bic Fem c l	Left	19.80	20.70	19.50
CON	Bic Fem c l	Left	16.30	16.10	17.10
CON	Bic Fem c l	Left	15.70	16.20	16.10
CON	Bic Fem c l	Left	14.20	14.20	13.90
CON	Bic Fem c l	Left	15.70	15.60	15.40
CON	Bic Fem c l	Left	16.70	16.00	16.30
CON	Bic Fem c l	Left	16.30	16.70	16.60
CON	Bic Fem c l	Left	18.30	17.50	17.90
CON	Bic Fem c l	Left	17.60	18.00	17.70
CON	Bic Fem c l	Left	15.10	14.30	15.20
CON	Bic Fem c l	Left	16.20	16.40	16.90
CON	Bic Fem c l	Left	14.90	15.20	14.40
CON	Bic Fem c l	Left	17.20	17.00	17.70
CON	Bic Fem c l	Right	13.90	13.20	19.50
CON	Bic Fem c l	Right	16.50	16.50	16.60
CON	Bic Fem c l	Right	16.70	16.50	16.80
CON	Bic Fem c l	Right	17.30	16.90	17.00
CON	Bic Fem c l	Right	15.80	16.20	16.50
CON	Bic Fem c l	Right	15.00	13.80	14.60
CON	Bic Fem c l	Right	15.70	18.20	16.20

CON	Bic Fem c l	Right	19.00	20.10	18.90
CON	Bic Fem c l	Right	14.50	13.50	13.40
CON	Bic Fem c l	Right	16.10	15.80	16.30
CON	Bic Fem c l	Right	19.30	19.30	19.90
CON	Bic Fem c l	Right	18.60	17.30	17.30
CON	Bic Fem c l	Right	16.90	16.40	17.20
CON	Bic Fem c l	Right	17.80	17.20	17.60
CON	Bic Fem c l	Right	15.60	15.00	15.40
CON	Bic Fem c l	Right	13.80	13.60	13.70
CON	Bic Fem c l	Right	16.50	16.70	16.20
CON	Bic Fem c l	Right	18.40	17.90	17.70
CON	Bic Fem c l	Right	17.40	16.90	18.40
CON	Bic Fem c l	Right	16.90	17.10	17.00
CON	Bic Fem c l	Right	14.30	14.30	14.10
CON	Bic Fem c l	Right	15.30	14.80	14.80
CON	Bic Fem c l	Right	17.10	16.90	18.10
CON	Bic Fem c l	Right	17.50	17.60	17.90
CON	Bic Fem c l	Right	17.60	17.50	18.10
CON	Bic Fem c l	Right	17.20	19.10	18.90
CON	Bic Fem c l	Right	15.30	15.70	15.10
CON	Bic Fem c l	Right	16.30	16.50	16.40
CON	Bic Fem c l	Right	16.30	15.10	15.60
CON	Bic Fem c l	Right	16.60	16.50	16.50
CON	Rect Femoris	Left	14.70	14.60	15.40
CON	Rect Femoris	Left	13.90	14.20	14.40
CON	Rect Femoris	Left	14.30	14.70	14.90
CON	Rect Femoris	Left	14.80	14.50	15.30
CON	Rect Femoris	Left	13.90	17.20	15.30
CON	Rect Femoris	Left	14.50	13.90	13.90
CON	Rect Femoris	Left	14.90	14.40	14.60
CON	Rect Femoris	Left	15.70	16.00	15.60
CON	Rect Femoris	Left	15.30	14.30	15.00
CON	Rect Femoris	Left	13.50	13.70	14.20
CON	Rect Femoris	Left	15.70	15.10	15.30
CON	Rect Femoris	Left	14.50	14.10	14.70
CON	Rect	Left	16.70	15.50	15.80

	Femoris				
CON	Rect Femoris	Left	14.60	15.10	15.60
CON	Rect Femoris	Left	14.20	14.60	14.80
CON	Rect Femoris	Left	15.20	14.30	15.40
CON	Rect Femoris	Left	14.80	15.10	15.00
CON	Rect Femoris	Left	14.00	15.20	14.30
CON	Rect Femoris	Left	15.10	15.20	15.40
CON	Rect Femoris	Left	15.50	15.90	15.70
CON	Rect Femoris	Left	13.90	15.10	14.90
CON	Rect Femoris	Left	14.80	14.30	14.80
CON	Rect Femoris	Left	14.10	14.10	14.30
CON	Rect Femoris	Left	14.00	14.00	13.90
CON	Rect Femoris	Left	17.90	17.90	16.30
CON	Rect Femoris	Left	16.00	15.50	15.70
CON	Rect Femoris	Left	16.90	16.70	17.40
CON	Rect Femoris	Left	15.20	14.40	15.40
CON	Rect Femoris	Left	14.90	14.70	15.00
CON	Rect Femoris	Left	14.50	14.00	15.60
CON	Rect Femoris	Right	14.60	15.00	15.50
CON	Rect Femoris	Right	14.50	14.90	15.10
CON	Rect Femoris	Right	14.80	14.60	15.20
CON	Rect Femoris	Right	15.00	15.40	15.30
CON	Rect Femoris	Right	15.80	15.60	15.00
CON	Rect Femoris	Right	13.50	13.30	13.50
CON	Rect Femoris	Right	16.00	15.20	16.00
CON	Rect	Right	15.50	15.30	15.60

	Femoris				
CON	Rect Femoris	Right	15.30	14.70	14.30
CON	Rect Femoris	Right	13.90	13.70	14.40
CON	Rect Femoris	Right	16.30	16.10	16.00
CON	Rect Femoris	Right	14.90	14.50	14.90
CON	Rect Femoris	Right	16.60	16.00	16.20
CON	Rect Femoris	Right	14.80	14.90	15.00
CON	Rect Femoris	Right	14.40	14.20	14.70
CON	Rect Femoris	Right	14.90	14.80	15.10
CON	Rect Femoris	Right	16.20	15.50	16.40
CON	Rect Femoris	Right	16.00	15.10	16.30
CON	Rect Femoris	Right	14.90	14.80	15.20
CON	Rect Femoris	Right	14.40	14.00	15.20
CON	Rect Femoris	Right	14.90	14.90	15.50
CON	Rect Femoris	Right	15.60	15.50	15.60
CON	Rect Femoris	Right	15.10	13.80	14.60
CON	Rect Femoris	Right	16.70	16.00	15.90
CON	Rect Femoris	Right	17.60	16.60	16.60
CON	Rect Femoris	Right	17.00	15.90	17.30
CON	Rect Femoris	Right	17.60	16.70	18.50
CON	Rect Femoris	Right	15.80	15.00	15.70
CON	Rect Femoris	Right	16.30	15.30	15.10
CON	Rect Femoris	Right	16.10	15.30	17.20
CON	Vastus lt	Left	16.10	16.00	16.10
CON	Vastus lt	Left	14.70	14.50	14.70
CON	Vastus lt	Left	21.30	18.80	22.30
CON	Vastus lt	Left	14.60	14.80	15.00
CON	Vastus lt	Left	20.20	19.70	17.90

CON	Vastus lt	Left	16.50	16.10	16.10
CON	Vastus lt	Left	15.40	15.80	15.60
CON	Vastus lt	Left	19.30	18.80	19.80
CON	Vastus lt	Left	15.80	14.50	15.50
CON	Vastus lt	Left	13.70	13.80	14.00
CON	Vastus lt	Left	15.40	16.00	15.60
CON	Vastus lt	Left	14.90	14.90	15.00
CON	Vastus lt	Left	19.60	18.70	18.90
CON	Vastus lt	Left	18.10	16.30	17.50
CON	Vastus lt	Left	16.00	15.90	16.80
CON	Vastus lt	Left	16.70	16.00	16.60
CON	Vastus lt	Left	17.70	19.80	18.60
CON	Vastus lt	Left	16.60	18.10	16.40
CON	Vastus lt	Left	16.30	16.60	16.90
CON	Vastus lt	Left	15.30	15.40	15.50
CON	Vastus lt	Left	16.90	16.70	16.20
CON	Vastus lt	Left	16.90	16.20	16.90
CON	Vastus lt	Left	17.00	18.10	17.60
CON	Vastus lt	Left	17.80	16.00	16.80
CON	Vastus lt	Left	22.80	20.40	22.30
CON	Vastus lt	Left	17.30	17.70	18.00
CON	Vastus lt	Left	19.60	19.30	20.40
CON	Vastus lt	Left	16.70	15.90	16.60
CON	Vastus lt	Left	18.40	17.90	18.30
CON	Vastus lt	Left	19.70	20.10	22.70
CON	Vastus lt	Right	16.00	16.20	17.50
CON	Vastus lt	Right	14.10	13.90	15.90
CON	Vastus lt	Right	17.80	17.60	20.70
CON	Vastus lt	Right	15.60	16.00	16.70
CON	Vastus lt	Right	18.40	17.60	17.30
CON	Vastus lt	Right	16.20	16.70	16.80
CON	Vastus lt	Right	17.90	17.40	17.30
CON	Vastus lt	Right	21.10	20.30	21.20
CON	Vastus lt	Right	16.20	14.50	15.40
CON	Vastus lt	Right	15.60	16.50	15.50
CON	Vastus lt	Right	17.50	19.30	17.90
CON	Vastus lt	Right	14.30	14.40	14.10
CON	Vastus lt	Right	18.10	16.70	16.90
CON	Vastus lt	Right	19.80	18.80	19.20
CON	Vastus lt	Right	16.20	15.50	17.50
CON	Vastus lt	Right	18.00	16.10	17.40
CON	Vastus lt	Right	17.10	16.30	17.40
CON	Vastus lt	Right	16.10	18.80	16.30
CON	Vastus lt	Right	15.50	15.30	15.10
CON	Vastus lt	Right	14.10	14.10	14.90

CON	Vastus lt	Right	16.40	15.40	16.70
CON	Vastus lt	Right	17.10	16.50	17.30
CON	Vastus lt	Right	18.10	18.00	19.30
CON	Vastus lt	Right	18.80	17.40	18.00
CON	Vastus lt	Right	21.90	19.00	20.20
CON	Vastus lt	Right	20.40	18.60	19.70
CON	Vastus lt	Right	18.50	18.10	19.20
CON	Vastus lt	Right	20.00	17.20	17.20
CON	Vastus lt	Right	15.00	17.00	18.00
CON	Vastus lt	Right	16.80	15.80	19.30
FLOSS	Bic Fem c l	Left	14.80	13.60	13.40
FLOSS	Bic Fem c l	Left	14.90	14.80	15.90
FLOSS	Bic Fem c l	Left	13.00	13.80	12.80
FLOSS	Bic Fem c l	Left	16.50	16.80	16.60
FLOSS	Bic Fem c l	Left	16.00	15.80	16.30
FLOSS	Bic Fem c l	Left	15.50	15.10	18.40
FLOSS	Bic Fem c l	Left	17.70	15.20	18.30
FLOSS	Bic Fem c l	Left	18.40	18.10	21.50
FLOSS	Bic Fem c l	Left	15.90	15.80	16.10
FLOSS	Bic Fem c l	Left	13.30	13.10	13.10
FLOSS	Bic Fem c l	Left	14.80	14.60	14.60
FLOSS	Bic Fem c l	Left	16.00	15.90	16.60
FLOSS	Bic Fem c l	Left	17.40	17.10	19.60
FLOSS	Bic Fem c l	Left	16.50	15.50	15.30
FLOSS	Bic Fem c l	Left	17.90	17.60	18.00
FLOSS	Bic Fem c l	Left	15.90	16.50	15.60
FLOSS	Bic Fem c l	Left	17.50	17.60	17.90
FLOSS	Bic Fem c l	Left	16.40	16.60	16.40
FLOSS	Bic Fem c l	Left	15.80	15.50	15.70
FLOSS	Bic Fem c l	Left	18.70	17.90	17.70
FLOSS	Bic Fem c l	Left	16.50	16.80	16.40
FLOSS	Bic Fem c l	Left	20.10	18.40	17.80
FLOSS	Bic Fem c l	Left	16.90	16.80	17.30
FLOSS	Bic Fem c l	Left	16.40	16.50	16.20
FLOSS	Bic Fem c l	Left	16.40	16.50	16.20
FLOSS	Bic Fem c l	Left	17.60	17.70	17.60
FLOSS	Bic Fem c l	Left	13.80	13.60	13.60
FLOSS	Bic Fem c l	Left	18.10	18.20	18.00
FLOSS	Bic Fem c l	Left	16.90	18.00	17.80
FLOSS	Bic Fem c l	Left	13.70	13.80	13.90
FLOSS	Bic Fem c l	Right	13.80	13.40	12.90
FLOSS	Bic Fem c l	Right	14.90	14.50	14.40
FLOSS	Bic Fem c l	Right	13.40	13.30	13.50
FLOSS	Bic Fem c l	Right	16.00	16.00	16.30
FLOSS	Bic Fem c l	Right	16.20	16.60	16.30

FLOSS	Bic Fem c l	Right	15.70	17.00	19.80
FLOSS	Bic Fem c l	Right	18.60	16.00	18.40
FLOSS	Bic Fem c l	Right	18.30	17.60	16.40
FLOSS	Bic Fem c l	Right	15.40	15.70	15.10
FLOSS	Bic Fem c l	Right	13.60	13.50	13.50
FLOSS	Bic Fem c l	Right	15.50	15.00	16.20
FLOSS	Bic Fem c l	Right	16.40	17.20	17.20
FLOSS	Bic Fem c l	Right	17.70	18.20	17.40
FLOSS	Bic Fem c l	Right	16.30	16.00	15.50
FLOSS	Bic Fem c l	Right	17.20	16.90	17.10
FLOSS	Bic Fem c l	Right	16.70	16.40	16.60
FLOSS	Bic Fem c l	Right	17.60	17.80	16.70
FLOSS	Bic Fem c l	Right	17.40	17.00	16.90
FLOSS	Bic Fem c l	Right	16.30	16.20	16.50
FLOSS	Bic Fem c l	Right	20.80	19.20	18.80
FLOSS	Bic Fem c l	Right	18.10	18.40	18.80
FLOSS	Bic Fem c l	Right	17.70	18.20	18.00
FLOSS	Bic Fem c l	Right	16.40	16.10	17.00
FLOSS	Bic Fem c l	Right	16.00	15.70	15.80
FLOSS	Bic Fem c l	Right	16.00	15.70	15.80
FLOSS	Bic Fem c l	Right	18.30	17.30	18.30
FLOSS	Bic Fem c l	Right	15.20	14.50	14.40
FLOSS	Bic Fem c l	Right	18.40	17.80	17.40
FLOSS	Bic Fem c l	Right	17.70	17.50	18.10
FLOSS	Bic Fem c l	Right	12.60	12.90	12.80
FLOSS	Rect Femoris	Left	14.80	15.00	14.80
FLOSS	Rect Femoris	Left	14.60	14.40	14.90
FLOSS	Rect Femoris	Left	15.10	13.90	14.50
FLOSS	Rect Femoris	Left	15.20	15.20	14.60
FLOSS	Rect Femoris	Left	14.60	13.80	15.60
FLOSS	Rect Femoris	Left	15.00	15.60	15.60
FLOSS	Rect Femoris	Left	15.20	14.60	16.10
FLOSS	Rect Femoris	Left	14.60	14.30	14.60
FLOSS	Rect Femoris	Left	14.20	14.00	14.50
FLOSS	Rect Femoris	Left	14.90	15.80	14.80
FLOSS	Rect Femoris	Left	15.10	14.40	15.50

FLOSS	Rect Femoris	Left	15.50	14.40	15.20
FLOSS	Rect Femoris	Left	16.00	14.90	15.00
FLOSS	Rect Femoris	Left	18.00	17.30	17.20
FLOSS	Rect Femoris	Left	14.50	14.20	14.10
FLOSS	Rect Femoris	Left	15.80	15.10	14.90
FLOSS	Rect Femoris	Left	16.90	15.30	15.90
FLOSS	Rect Femoris	Left	15.20	14.70	14.80
FLOSS	Rect Femoris	Left	16.80	17.20	15.70
FLOSS	Rect Femoris	Left	15.70	15.40	15.30
FLOSS	Rect Femoris	Left	14.40	15.30	14.40
FLOSS	Rect Femoris	Left	14.90	14.50	14.40
FLOSS	Rect Femoris	Left	15.30	15.10	15.90
FLOSS	Rect Femoris	Left	15.10	14.60	15.60
FLOSS	Rect Femoris	Left	15.10	14.60	15.60
FLOSS	Rect Femoris	Left	16.10	15.90	15.30
FLOSS	Rect Femoris	Left	15.00	14.00	13.90
FLOSS	Rect Femoris	Left	17.50	17.00	16.90
FLOSS	Rect Femoris	Left	16.60	15.60	16.20
FLOSS	Rect Femoris	Left	14.80	13.30	13.50
FLOSS	Rect Femoris	Right	15.20	15.20	15.40
FLOSS	Rect Femoris	Right	16.10	14.90	15.90
FLOSS	Rect Femoris	Right	13.90	13.50	13.50
FLOSS	Rect Femoris	Right	16.50	16.40	16.70
FLOSS	Rect Femoris	Right	15.50	14.30	15.10
FLOSS	Rect Femoris	Right	14.10	14.60	16.50

FLOSS	Rect Femoris	Right	16.10	14.00	16.20
FLOSS	Rect Femoris	Right	15.20	14.00	14.90
FLOSS	Rect Femoris	Right	14.60	14.90	15.20
FLOSS	Rect Femoris	Right	15.70	15.70	15.00
FLOSS	Rect Femoris	Right	15.50	15.60	16.20
FLOSS	Rect Femoris	Right	15.30	14.60	15.10
FLOSS	Rect Femoris	Right	15.40	14.40	15.30
FLOSS	Rect Femoris	Right	17.90	17.70	18.00
FLOSS	Rect Femoris	Right	15.20	14.30	14.50
FLOSS	Rect Femoris	Right	16.40	15.50	15.60
FLOSS	Rect Femoris	Right	16.80	16.70	16.70
FLOSS	Rect Femoris	Right	15.10	14.50	14.90
FLOSS	Rect Femoris	Right	15.40	15.80	14.70
FLOSS	Rect Femoris	Right	16.10	15.20	15.60
FLOSS	Rect Femoris	Right	15.40	14.60	16.70
FLOSS	Rect Femoris	Right	14.00	15.50	14.80
FLOSS	Rect Femoris	Right	16.00	14.90	15.50
FLOSS	Rect Femoris	Right	15.80	15.60	15.80
FLOSS	Rect Femoris	Right	15.80	15.60	15.80
FLOSS	Rect Femoris	Right	14.70	14.50	15.10
FLOSS	Rect Femoris	Right	15.30	14.70	14.90
FLOSS	Rect Femoris	Right	17.30	17.30	17.20
FLOSS	Rect Femoris	Right	17.00	16.00	17.20
FLOSS	Rect Femoris	Right	15.10	14.30	14.80
FLOSS	Vastus lt	Left	15.10	14.70	15.30
FLOSS	Vastus lt	Left	16.40	15.60	16.40

FLOSS	Vastus lt	Left	16.20	16.60	15.60
FLOSS	Vastus lt	Left	20.70	22.30	20.70
FLOSS	Vastus lt	Left	18.80	15.80	18.70
FLOSS	Vastus lt	Left	15.20	14.80	16.00
FLOSS	Vastus lt	Left	15.90	15.20	17.00
FLOSS	Vastus lt	Left	15.90	16.10	15.10
FLOSS	Vastus lt	Left	16.00	16.00	16.10
FLOSS	Vastus lt	Left	16.50	15.20	16.50
FLOSS	Vastus lt	Left	18.20	16.80	18.20
FLOSS	Vastus lt	Left	15.80	16.40	16.90
FLOSS	Vastus lt	Left	14.30	15.10	14.50
FLOSS	Vastus lt	Left	21.50	20.90	20.60
FLOSS	Vastus lt	Left	15.70	15.30	14.80
FLOSS	Vastus lt	Left	17.70	19.00	18.70
FLOSS	Vastus lt	Left	20.40	19.30	18.90
FLOSS	Vastus lt	Left	22.20	19.50	20.10
FLOSS	Vastus lt	Left	19.40	19.30	17.70
FLOSS	Vastus lt	Left	19.90	17.70	19.20
FLOSS	Vastus lt	Left	16.70	16.20	16.30
FLOSS	Vastus lt	Left	16.90	16.10	16.30
FLOSS	Vastus lt	Left	16.70	16.60	17.30
FLOSS	Vastus lt	Left	16.90	15.40	16.00
FLOSS	Vastus lt	Left	16.90	15.40	16.00
FLOSS	Vastus lt	Left	17.20	15.70	16.60
FLOSS	Vastus lt	Left	16.70	15.70	16.30
FLOSS	Vastus lt	Left	21.50	20.80	20.90
FLOSS	Vastus lt	Left	19.30	19.20	20.80
FLOSS	Vastus lt	Left	15.10	14.70	14.10
FLOSS	Vastus lt	Right	16.00	15.90	16.60
FLOSS	Vastus lt	Right	17.30	16.00	16.90
FLOSS	Vastus lt	Right	16.70	16.80	16.80
FLOSS	Vastus lt	Right	19.00	19.10	18.10
FLOSS	Vastus lt	Right	16.90	16.10	19.30
FLOSS	Vastus lt	Right	13.70	14.70	17.90
FLOSS	Vastus lt	Right	17.70	14.20	19.20
FLOSS	Vastus lt	Right	15.00	15.50	14.20
FLOSS	Vastus lt	Right	18.70	17.60	17.70
FLOSS	Vastus lt	Right	17.90	15.40	17.30
FLOSS	Vastus lt	Right	17.90	17.50	18.30
FLOSS	Vastus lt	Right	15.60	14.80	15.40
FLOSS	Vastus lt	Right	16.10	15.60	16.10
FLOSS	Vastus lt	Right	20.00	18.90	19.00
FLOSS	Vastus lt	Right	15.30	14.10	14.20
FLOSS	Vastus lt	Right	17.40	16.40	16.20
FLOSS	Vastus lt	Right	17.10	17.00	17.40

FLOSS	Vastus lt	Right	23.70	23.40	23.90
FLOSS	Vastus lt	Right	18.70	17.70	17.70
FLOSS	Vastus lt	Right	21.20	19.20	19.70
FLOSS	Vastus lt	Right	15.50	16.80	18.30
FLOSS	Vastus lt	Right	19.90	15.60	20.20
FLOSS	Vastus lt	Right	19.00	17.60	18.40
FLOSS	Vastus lt	Right	18.60	18.10	17.40
FLOSS	Vastus lt	Right	18.60	18.10	17.40
FLOSS	Vastus lt	Right	20.10	19.30	20.00
FLOSS	Vastus lt	Right	17.10	15.60	16.30
FLOSS	Vastus lt	Right	21.80	19.60	18.90
FLOSS	Vastus lt	Right	19.60	17.70	18.80
FLOSS	Vastus lt	Right	16.20	15.70	15.40
FR	Bic Fem c l	Left	17.80	17.70	20.30
FR	Bic Fem c l	Left	15.70	15.70	15.90
FR	Bic Fem c l	Left	15.60	15.20	15.20
FR	Bic Fem c l	Left	18.00	18.30	18.20
FR	Bic Fem c l	Left	13.50	13.60	13.90
FR	Bic Fem c l	Left	12.70	12.60	12.70
FR	Bic Fem c l	Left	16.50	16.40	16.50
FR	Bic Fem c l	Left	17.40	17.10	17.80
FR	Bic Fem c l	Left	17.50	17.10	17.00
FR	Bic Fem c l	Left	15.70	15.60	15.40
FR	Bic Fem c l	Left	15.70	16.20	15.70
FR	Bic Fem c l	Left	14.00	14.80	15.00
FR	Bic Fem c l	Left	18.40	17.40	19.10
FR	Bic Fem c l	Left	13.10	13.20	13.30
FR	Bic Fem c l	Left	13.40	13.40	13.10
FR	Bic Fem c l	Left	16.70	16.80	16.30
FR	Bic Fem c l	Left	16.50	16.40	17.30
FR	Bic Fem c l	Left	15.70	15.80	16.30
FR	Bic Fem c l	Left	18.40	18.10	18.20
FR	Bic Fem c l	Left	16.50	16.60	17.20
FR	Bic Fem c l	Left	16.00	15.60	16.30
FR	Bic Fem c l	Left	14.10	14.40	14.50
FR	Bic Fem c l	Left	17.30	17.40	17.00
FR	Bic Fem c l	Left	17.20	17.10	17.80
FR	Bic Fem c l	Left	15.40	15.20	16.20
FR	Bic Fem c l	Left	14.20	14.80	15.70
FR	Bic Fem c l	Left	16.40	17.00	17.10
FR	Bic Fem c l	Left	17.00	16.50	16.80
FR	Bic Fem c l	Left	19.60	20.60	19.10
FR	Bic Fem c l	Left	16.50	16.50	17.60
FR	Bic Fem c l	Right	18.00	19.10	18.90
FR	Bic Fem c l	Right	16.00	15.80	17.70

FR	Bic Fem c l	Right	19.10	16.40	18.60
FR	Bic Fem c l	Right	19.70	19.10	19.00
FR	Bic Fem c l	Right	14.00	14.10	14.30
FR	Bic Fem c l	Right	13.00	13.50	13.70
FR	Bic Fem c l	Right	16.70	17.00	16.60
FR	Bic Fem c l	Right	16.70	16.50	16.80
FR	Bic Fem c l	Right	17.90	17.40	17.70
FR	Bic Fem c l	Right	14.90	14.90	14.80
FR	Bic Fem c l	Right	15.50	15.60	16.00
FR	Bic Fem c l	Right	13.70	13.60	14.00
FR	Bic Fem c l	Right	16.40	16.60	16.40
FR	Bic Fem c l	Right	13.80	13.90	14.10
FR	Bic Fem c l	Right	13.80	13.40	14.30
FR	Bic Fem c l	Right	17.00	16.80	18.10
FR	Bic Fem c l	Right	16.20	17.30	16.40
FR	Bic Fem c l	Right	16.90	16.40	17.10
FR	Bic Fem c l	Right	18.20	18.20	17.20
FR	Bic Fem c l	Right	16.40	15.80	16.40
FR	Bic Fem c l	Right	15.90	15.20	15.80
FR	Bic Fem c l	Right	15.10	15.40	16.20
FR	Bic Fem c l	Right	16.70	18.00	17.20
FR	Bic Fem c l	Right	17.10	17.50	18.30
FR	Bic Fem c l	Right	15.90	15.50	16.00
FR	Bic Fem c l	Right	14.70	15.00	15.90
FR	Bic Fem c l	Right	17.80	17.40	18.40
FR	Bic Fem c l	Right	15.70	16.10	16.30
FR	Bic Fem c l	Right	18.00	17.60	18.70
FR	Bic Fem c l	Right	17.60	17.50	17.90
FR	Rect Femoris	Left	15.00	15.20	16.10
FR	Rect Femoris	Left	15.00	14.60	15.20
FR	Rect Femoris	Left	15.40	15.00	15.00
FR	Rect Femoris	Left	15.20	15.40	15.90
FR	Rect Femoris	Left	14.40	14.10	14.40
FR	Rect Femoris	Left	15.30	15.70	14.30
FR	Rect Femoris	Left	14.70	15.00	15.70
FR	Rect Femoris	Left	14.20	14.10	14.50
FR	Rect Femoris	Left	15.00	15.20	14.70
FR	Rect	Left	14.90	15.00	15.00

	Femoris				
FR	Rect Femoris	Left	14.80	15.10	15.40
FR	Rect Femoris	Left	14.30	14.30	15.40
FR	Rect Femoris	Left	13.80	13.50	14.60
FR	Rect Femoris	Left	14.60	14.00	15.00
FR	Rect Femoris	Left	14.30	13.70	14.20
FR	Rect Femoris	Left	14.30	14.50	14.60
FR	Rect Femoris	Left	15.20	15.00	14.90
FR	Rect Femoris	Left	14.00	14.20	14.20
FR	Rect Femoris	Left	14.20	14.30	14.40
FR	Rect Femoris	Left	14.80	14.30	14.70
FR	Rect Femoris	Left	15.00	14.50	14.70
FR	Rect Femoris	Left	14.90	15.00	15.00
FR	Rect Femoris	Left	15.20	15.80	15.80
FR	Rect Femoris	Left	17.30	17.50	19.40
FR	Rect Femoris	Left	16.50	15.70	17.80
FR	Rect Femoris	Left	17.10	16.70	17.00
FR	Rect Femoris	Left	13.60	14.20	14.30
FR	Rect Femoris	Left	15.10	15.60	15.20
FR	Rect Femoris	Left	15.20	13.80	14.40
FR	Rect Femoris	Left	14.20	14.90	15.50
FR	Rect Femoris	Right	15.50	15.40	16.10
FR	Rect Femoris	Right	14.80	14.20	15.30
FR	Rect Femoris	Right	14.60	14.20	14.50
FR	Rect Femoris	Right	15.60	15.10	16.10
FR	Rect	Right	14.20	14.90	15.10

	Femoris Rect				
FR	Femoris Rect	Right	15.50	15.60	16.60
FR	Femoris Rect	Right	15.60	15.40	15.70
FR	Femoris Rect	Right	14.60	14.50	14.80
FR	Femoris Rect	Right	14.70	14.80	15.40
FR	Femoris Rect	Right	15.00	15.50	15.80
FR	Femoris Rect	Right	14.90	14.90	15.80
FR	Femoris Rect	Right	14.50	14.50	15.90
FR	Femoris Rect	Right	13.90	13.90	14.70
FR	Femoris Rect	Right	14.20	14.10	14.70
FR	Femoris Rect	Right	13.10	13.40	13.70
FR	Femoris Rect	Right	14.50	14.60	14.70
FR	Femoris Rect	Right	16.80	16.40	15.50
FR	Femoris Rect	Right	13.80	14.20	15.30
FR	Femoris Rect	Right	14.80	14.90	14.80
FR	Femoris Rect	Right	16.00	15.50	16.20
FR	Femoris Rect	Right	14.70	14.00	15.10
FR	Femoris Rect	Right	15.30	16.30	15.40
FR	Femoris Rect	Right	16.30	16.70	17.80
FR	Femoris Rect	Right	17.20	17.30	16.70
FR	Femoris Rect	Right	16.20	14.50	15.80
FR	Femoris Rect	Right	16.60	16.30	17.20
FR	Femoris Rect	Right	16.20	15.30	15.70
FR	Femoris Rect	Right	15.00	15.60	15.70
FR	Femoris	Right	15.90	15.40	13.90
FR	Rect	Right	15.20	15.40	15.10

	Femoris				
FR	Vastus lt	Left	16.10	16.20	16.80
FR	Vastus lt	Left	16.00	15.70	16.50
FR	Vastus lt	Left	15.00	15.20	16.00
FR	Vastus lt	Left	17.00	18.30	19.80
FR	Vastus lt	Left	15.40	15.30	16.00
FR	Vastus lt	Left	16.00	15.20	16.00
FR	Vastus lt	Left	18.10	17.00	18.10
FR	Vastus lt	Left	14.30	14.20	14.70
FR	Vastus lt	Left	16.00	16.00	16.30
FR	Vastus lt	Left	16.00	16.70	16.60
FR	Vastus lt	Left	15.50	15.90	18.60
FR	Vastus lt	Left	13.90	14.80	14.90
FR	Vastus lt	Left	14.00	14.20	14.60
FR	Vastus lt	Left	14.70	14.60	16.00
FR	Vastus lt	Left	16.10	15.70	16.50
FR	Vastus lt	Left	21.00	21.00	20.90
FR	Vastus lt	Left	21.00	22.00	19.80
FR	Vastus lt	Left	16.70	16.30	17.20
FR	Vastus lt	Left	14.90	15.20	15.00
FR	Vastus lt	Left	14.90	15.00	16.00
FR	Vastus lt	Left	15.60	16.10	16.20
FR	Vastus lt	Left	15.20	16.00	16.00
FR	Vastus lt	Left	19.10	19.40	19.90
FR	Vastus lt	Left	20.80	21.20	21.90
FR	Vastus lt	Left	19.50	17.90	20.70
FR	Vastus lt	Left	18.60	18.50	20.50
FR	Vastus lt	Left	14.10	14.40	17.90
FR	Vastus lt	Left	17.70	17.80	17.90
FR	Vastus lt	Left	15.70	15.80	15.70
FR	Vastus lt	Left	13.90	14.30	14.50
FR	Vastus lt	Right	18.90	16.90	18.90
FR	Vastus lt	Right	15.20	14.50	15.30
FR	Vastus lt	Right	13.60	14.20	14.00
FR	Vastus lt	Right	19.50	19.30	20.40
FR	Vastus lt	Right	15.60	14.70	15.70
FR	Vastus lt	Right	16.50	15.10	16.80
FR	Vastus lt	Right	16.20	16.40	17.10
FR	Vastus lt	Right	13.90	14.30	14.50
FR	Vastus lt	Right	18.90	17.60	18.80
FR	Vastus lt	Right	17.10	16.20	17.30
FR	Vastus lt	Right	16.60	18.10	18.70
FR	Vastus lt	Right	15.60	15.60	15.70
FR	Vastus lt	Right	16.30	16.30	17.30
FR	Vastus lt	Right	15.00	14.80	16.00

FR	Vastus lt	Right	16.80	16.40	17.20
FR	Vastus lt	Right	18.00	20.30	23.90
FR	Vastus lt	Right	18.70	18.50	15.20
FR	Vastus lt	Right	18.00	17.70	18.70
FR	Vastus lt	Right	14.50	14.10	13.90
FR	Vastus lt	Right	16.80	17.90	17.30
FR	Vastus lt	Right	15.90	15.40	16.90
FR	Vastus lt	Right	14.20	15.10	14.60
FR	Vastus lt	Right	18.10	18.20	19.00
FR	Vastus lt	Right	20.10	20.80	20.50
FR	Vastus lt	Right	18.00	16.90	17.60
FR	Vastus lt	Right	17.50	17.20	19.00
FR	Vastus lt	Right	14.90	14.90	19.10
FR	Vastus lt	Right	16.70	16.20	16.80
FR	Vastus lt	Right	15.60	15.90	19.40
FR	Vastus lt	Right	15.80	15.60	15.90

Annex 7. Muscle stiffness [N/m]. Con- Control conditioning, FLOSS- tissue flossing conditioning, FR- foam rolling conditioning, Bic Fem c l -Biceps Femoris Caput longum, Rect – Rectus, Vastus lt- Vastus Lateralis

Conditioning	Object	Side	Stiffness_Post1	Stiffness_Post2	Stiffness_Pre
CON	Bic Fem c l	Left	260.00	239.00	358.00
CON	Bic Fem c l	Left	321.00	311.00	323.00
CON	Bic Fem c l	Left	314.00	312.00	324.00
CON	Bic Fem c l	Left	342.00	329.00	333.00
CON	Bic Fem c l	Left	290.00	295.00	310.00
CON	Bic Fem c l	Left	207.00	214.00	220.00
CON	Bic Fem c l	Left	292.00	302.00	282.00
CON	Bic Fem c l	Left	340.00	350.00	351.00
CON	Bic Fem c l	Left	230.00	218.00	227.00
CON	Bic Fem c l	Left	329.00	325.00	321.00
CON	Bic Fem c l	Left	354.00	360.00	351.00
CON	Bic Fem c l	Left	327.00	317.00	308.00
CON	Bic Fem c l	Left	371.00	335.00	349.00
CON	Bic Fem c l	Left	315.00	318.00	326.00
CON	Bic Fem c l	Left	285.00	284.00	293.00
CON	Bic Fem c l	Left	236.00	227.00	244.00
CON	Bic Fem c l	Left	293.00	283.00	290.00
CON	Bic Fem c l	Left	405.00	459.00	381.00
CON	Bic Fem c l	Left	285.00	281.00	307.00
CON	Bic Fem c l	Left	272.00	294.00	286.00
CON	Bic Fem c l	Left	229.00	234.00	229.00
CON	Bic Fem c l	Left	299.00	301.00	291.00
CON	Bic Fem c l	Left	299.00	278.00	294.00
CON	Bic Fem c l	Left	311.00	314.00	308.00
CON	Bic Fem c l	Left	364.00	341.00	353.00
CON	Bic Fem c l	Left	347.00	376.00	351.00
CON	Bic Fem c l	Left	261.00	247.00	265.00
CON	Bic Fem c l	Left	298.00	305.00	319.00
CON	Bic Fem c l	Left	243.00	247.00	238.00
CON	Bic Fem c l	Left	332.00	334.00	345.00
CON	Bic Fem c l	Right	226.00	212.00	370.00
CON	Bic Fem c l	Right	307.00	307.00	306.00
CON	Bic Fem c l	Right	318.00	323.00	322.00
CON	Bic Fem c l	Right	310.00	304.00	324.00
CON	Bic Fem c l	Right	291.00	299.00	298.00
CON	Bic Fem c l	Right	246.00	230.00	237.00

CON	Bic Fem c l	Right	268.00	320.00	280.00
CON	Bic Fem c l	Right	359.00	393.00	354.00
CON	Bic Fem c l	Right	248.00	225.00	220.00
CON	Bic Fem c l	Right	291.00	286.00	307.00
CON	Bic Fem c l	Right	364.00	369.00	380.00
CON	Bic Fem c l	Right	338.00	303.00	302.00
CON	Bic Fem c l	Right	333.00	330.00	339.00
CON	Bic Fem c l	Right	339.00	339.00	337.00
CON	Bic Fem c l	Right	285.00	276.00	288.00
CON	Bic Fem c l	Right	253.00	258.00	253.00
CON	Bic Fem c l	Right	294.00	297.00	292.00
CON	Bic Fem c l	Right	358.00	351.00	353.00
CON	Bic Fem c l	Right	310.00	313.00	332.00
CON	Bic Fem c l	Right	303.00	308.00	306.00
CON	Bic Fem c l	Right	233.00	228.00	227.00
CON	Bic Fem c l	Right	277.00	261.00	266.00
CON	Bic Fem c l	Right	342.00	306.00	343.00
CON	Bic Fem c l	Right	313.00	318.00	328.00
CON	Bic Fem c l	Right	325.00	325.00	338.00
CON	Bic Fem c l	Right	338.00	403.00	398.00
CON	Bic Fem c l	Right	265.00	273.00	260.00
CON	Bic Fem c l	Right	317.00	316.00	317.00
CON	Bic Fem c l	Right	264.00	239.00	250.00
CON	Bic Fem c l	Right	326.00	315.00	324.00
CON	Rect Femoris	Left	276.00	271.00	258.00
CON	Rect Femoris	Left	226.00	227.00	236.00
CON	Rect Femoris	Left	230.00	249.00	251.00
CON	Rect Femoris	Left	239.00	238.00	255.00
CON	Rect Femoris	Left	269.00	283.00	257.00
CON	Rect Femoris	Left	253.00	234.00	235.00
CON	Rect Femoris	Left	253.00	249.00	255.00
CON	Rect Femoris	Left	270.00	271.00	272.00
CON	Rect Femoris	Left	266.00	234.00	254.00
CON	Rect Femoris	Left	221.00	221.00	231.00
CON	Rect Femoris	Left	269.00	257.00	258.00
CON	Rect Femoris	Left	248.00	238.00	241.00

CON	Rect Femoris	Left	288.00	276.00	282.00
CON	Rect Femoris	Left	273.00	273.00	276.00
CON	Rect Femoris	Left	234.00	246.00	246.00
CON	Rect Femoris	Left	269.00	253.00	257.00
CON	Rect Femoris	Left	270.00	268.00	271.00
CON	Rect Femoris	Left	256.00	260.00	259.00
CON	Rect Femoris	Left	237.00	244.00	246.00
CON	Rect Femoris	Left	264.00	255.00	263.00
CON	Rect Femoris	Left	262.00	262.00	275.00
CON	Rect Femoris	Left	252.00	236.00	255.00
CON	Rect Femoris	Left	260.00	258.00	272.00
CON	Rect Femoris	Left	253.00	240.00	248.00
CON	Rect Femoris	Left	317.00	303.00	304.00
CON	Rect Femoris	Left	299.00	304.00	291.00
CON	Rect Femoris	Left	298.00	293.00	299.00
CON	Rect Femoris	Left	268.00	263.00	283.00
CON	Rect Femoris	Left	263.00	250.00	263.00
CON	Rect Femoris	Left	239.00	227.00	247.00
CON	Rect Femoris	Right	260.00	270.00	272.00
CON	Rect Femoris	Right	232.00	233.00	234.00
CON	Rect Femoris	Right	247.00	244.00	270.00
CON	Rect Femoris	Right	244.00	261.00	258.00
CON	Rect Femoris	Right	254.00	258.00	245.00
CON	Rect Femoris	Right	220.00	209.00	219.00
CON	Rect Femoris	Right	300.00	277.00	302.00

CON	Rect Femoris	Right	270.00	266.00	274.00
CON	Rect Femoris	Right	278.00	259.00	247.00
CON	Rect Femoris	Right	232.00	232.00	236.00
CON	Rect Femoris	Right	276.00	270.00	270.00
CON	Rect Femoris	Right	267.00	257.00	263.00
CON	Rect Femoris	Right	283.00	274.00	277.00
CON	Rect Femoris	Right	257.00	261.00	268.00
CON	Rect Femoris	Right	233.00	235.00	244.00
CON	Rect Femoris	Right	263.00	251.00	259.00
CON	Rect Femoris	Right	288.00	283.00	302.00
CON	Rect Femoris	Right	260.00	259.00	268.00
CON	Rect Femoris	Right	229.00	235.00	234.00
CON	Rect Femoris	Right	246.00	245.00	258.00
CON	Rect Femoris	Right	255.00	242.00	261.00
CON	Rect Femoris	Right	274.00	275.00	280.00
CON	Rect Femoris	Right	254.00	243.00	255.00
CON	Rect Femoris	Right	289.00	266.00	274.00
CON	Rect Femoris	Right	302.00	292.00	296.00
CON	Rect Femoris	Right	318.00	299.00	311.00
CON	Rect Femoris	Right	286.00	280.00	296.00
CON	Rect Femoris	Right	293.00	292.00	296.00
CON	Rect Femoris	Right	267.00	250.00	266.00
CON	Rect Femoris	Right	243.00	238.00	273.00
CON	Vastus lt	Left	298.00	285.00	309.00
CON	Vastus lt	Left	275.00	271.00	260.00
CON	Vastus lt	Left	387.00	381.00	420.00
CON	Vastus lt	Left	258.00	264.00	263.00

CON	Vastus lt	Left	380.00	384.00	325.00
CON	Vastus lt	Left	327.00	310.00	315.00
CON	Vastus lt	Left	300.00	295.00	297.00
CON	Vastus lt	Left	376.00	363.00	386.00
CON	Vastus lt	Left	320.00	288.00	314.00
CON	Vastus lt	Left	256.00	252.00	252.00
CON	Vastus lt	Left	312.00	301.00	306.00
CON	Vastus lt	Left	267.00	277.00	269.00
CON	Vastus lt	Left	371.00	351.00	352.00
CON	Vastus lt	Left	345.00	327.00	336.00
CON	Vastus lt	Left	276.00	277.00	290.00
CON	Vastus lt	Left	313.00	301.00	309.00
CON	Vastus lt	Left	362.00	359.00	394.00
CON	Vastus lt	Left	327.00	330.00	325.00
CON	Vastus lt	Left	295.00	295.00	300.00
CON	Vastus lt	Left	286.00	293.00	279.00
CON	Vastus lt	Left	338.00	324.00	324.00
CON	Vastus lt	Left	314.00	297.00	311.00
CON	Vastus lt	Left	292.00	314.00	309.00
CON	Vastus lt	Left	321.00	293.00	306.00
CON	Vastus lt	Left	480.00	402.00	476.00
CON	Vastus lt	Left	339.00	349.00	346.00
CON	Vastus lt	Left	350.00	365.00	382.00
CON	Vastus lt	Left	316.00	293.00	303.00
CON	Vastus lt	Left	347.00	340.00	358.00
CON	Vastus lt	Left	340.00	324.00	411.00
CON	Vastus lt	Right	305.00	305.00	356.00
CON	Vastus lt	Right	266.00	255.00	273.00
CON	Vastus lt	Right	341.00	344.00	386.00
CON	Vastus lt	Right	274.00	284.00	287.00
CON	Vastus lt	Right	345.00	321.00	307.00
CON	Vastus lt	Right	331.00	334.00	337.00
CON	Vastus lt	Right	359.00	334.00	348.00
CON	Vastus lt	Right	433.00	401.00	426.00
CON	Vastus lt	Right	337.00	287.00	321.00
CON	Vastus lt	Right	284.00	281.00	290.00
CON	Vastus lt	Right	347.00	347.00	353.00
CON	Vastus lt	Right	280.00	286.00	270.00
CON	Vastus lt	Right	349.00	330.00	325.00
CON	Vastus lt	Right	370.00	349.00	358.00
CON	Vastus lt	Right	292.00	283.00	313.00
CON	Vastus lt	Right	346.00	306.00	328.00
CON	Vastus lt	Right	304.00	290.00	317.00
CON	Vastus lt	Right	332.00	335.00	338.00
CON	Vastus lt	Right	276.00	266.00	263.00

CON	Vastus lt	Right	278.00	265.00	291.00
CON	Vastus lt	Right	325.00	308.00	350.00
CON	Vastus lt	Right	339.00	309.00	322.00
CON	Vastus lt	Right	326.00	326.00	351.00
CON	Vastus lt	Right	345.00	322.00	334.00
CON	Vastus lt	Right	438.00	379.00	407.00
CON	Vastus lt	Right	385.00	347.00	373.00
CON	Vastus lt	Right	354.00	339.00	367.00
CON	Vastus lt	Right	357.00	315.00	320.00
CON	Vastus lt	Right	296.00	297.00	329.00
CON	Vastus lt	Right	297.00	280.00	324.00
FLOSS	Bic Fem c l	Left	263.00	231.00	216.00
FLOSS	Bic Fem c l	Left	276.00	277.00	291.00
FLOSS	Bic Fem c l	Left	196.00	218.00	196.00
FLOSS	Bic Fem c l	Left	330.00	335.00	337.00
FLOSS	Bic Fem c l	Left	285.00	280.00	291.00
FLOSS	Bic Fem c l	Left	275.00	264.00	353.00
FLOSS	Bic Fem c l	Left	341.00	264.00	351.00
FLOSS	Bic Fem c l	Left	331.00	320.00	414.00
FLOSS	Bic Fem c l	Left	272.00	274.00	279.00
FLOSS	Bic Fem c l	Left	236.00	235.00	230.00
FLOSS	Bic Fem c l	Left	238.00	241.00	235.00
FLOSS	Bic Fem c l	Left	279.00	278.00	298.00
FLOSS	Bic Fem c l	Left	336.00	334.00	399.00
FLOSS	Bic Fem c l	Left	283.00	272.00	271.00
FLOSS	Bic Fem c l	Left	330.00	330.00	335.00
FLOSS	Bic Fem c l	Left	274.00	291.00	270.00
FLOSS	Bic Fem c l	Left	351.00	359.00	353.00
FLOSS	Bic Fem c l	Left	315.00	316.00	311.00
FLOSS	Bic Fem c l	Left	296.00	296.00	287.00
FLOSS	Bic Fem c l	Left	345.00	325.00	332.00
FLOSS	Bic Fem c l	Left	302.00	308.00	301.00
FLOSS	Bic Fem c l	Left	412.00	364.00	344.00
FLOSS	Bic Fem c l	Left	312.00	316.00	325.00
FLOSS	Bic Fem c l	Left	275.00	277.00	270.00
FLOSS	Bic Fem c l	Left	275.00	277.00	270.00
FLOSS	Bic Fem c l	Left	323.00	324.00	327.00
FLOSS	Bic Fem c l	Left	220.00	218.00	211.00
FLOSS	Bic Fem c l	Left	352.00	343.00	343.00
FLOSS	Bic Fem c l	Left	330.00	365.00	353.00
FLOSS	Bic Fem c l	Left	235.00	238.00	247.00
FLOSS	Bic Fem c l	Right	218.00	224.00	202.00
FLOSS	Bic Fem c l	Right	262.00	255.00	247.00
FLOSS	Bic Fem c l	Right	210.00	211.00	214.00
FLOSS	Bic Fem c l	Right	301.00	295.00	316.00

FLOSS	Bic Fem c l	Right	284.00	300.00	290.00
FLOSS	Bic Fem c l	Right	278.00	309.00	367.00
FLOSS	Bic Fem c l	Right	339.00	288.00	339.00
FLOSS	Bic Fem c l	Right	334.00	319.00	303.00
FLOSS	Bic Fem c l	Right	278.00	285.00	271.00
FLOSS	Bic Fem c l	Right	244.00	245.00	245.00
FLOSS	Bic Fem c l	Right	242.00	246.00	260.00
FLOSS	Bic Fem c l	Right	282.00	304.00	303.00
FLOSS	Bic Fem c l	Right	314.00	336.00	321.00
FLOSS	Bic Fem c l	Right	285.00	284.00	271.00
FLOSS	Bic Fem c l	Right	321.00	311.00	321.00
FLOSS	Bic Fem c l	Right	297.00	296.00	300.00
FLOSS	Bic Fem c l	Right	339.00	341.00	328.00
FLOSS	Bic Fem c l	Right	323.00	320.00	322.00
FLOSS	Bic Fem c l	Right	296.00	307.00	304.00
FLOSS	Bic Fem c l	Right	433.00	384.00	362.00
FLOSS	Bic Fem c l	Right	323.00	331.00	339.00
FLOSS	Bic Fem c l	Right	333.00	354.00	353.00
FLOSS	Bic Fem c l	Right	307.00	306.00	321.00
FLOSS	Bic Fem c l	Right	273.00	267.00	267.00
FLOSS	Bic Fem c l	Right	273.00	267.00	267.00
FLOSS	Bic Fem c l	Right	350.00	327.00	341.00
FLOSS	Bic Fem c l	Right	256.00	239.00	240.00
FLOSS	Bic Fem c l	Right	340.00	323.00	325.00
FLOSS	Bic Fem c l	Right	339.00	331.00	338.00
FLOSS	Bic Fem c l	Right	192.00	202.00	196.00
FLOSS	Rect Femoris	Left	261.00	260.00	260.00
FLOSS	Rect Femoris	Left	246.00	243.00	254.00
FLOSS	Rect Femoris	Left	260.00	231.00	247.00
FLOSS	Rect Femoris	Left	242.00	245.00	242.00
FLOSS	Rect Femoris	Left	261.00	252.00	279.00
FLOSS	Rect Femoris	Left	256.00	249.00	259.00
FLOSS	Rect Femoris	Left	259.00	244.00	266.00
FLOSS	Rect Femoris	Left	260.00	254.00	249.00
FLOSS	Rect Femoris	Left	231.00	243.00	234.00
FLOSS	Rect Femoris	Left	259.00	241.00	254.00
FLOSS	Rect	Left	266.00	249.00	267.00

	Femoris				
FLOSS	Rect Femoris	Left	243.00	231.00	247.00
FLOSS	Rect Femoris	Left	253.00	241.00	245.00
FLOSS	Rect Femoris	Left	320.00	304.00	308.00
FLOSS	Rect Femoris	Left	243.00	234.00	229.00
FLOSS	Rect Femoris	Left	281.00	275.00	272.00
FLOSS	Rect Femoris	Left	299.00	288.00	284.00
FLOSS	Rect Femoris	Left	276.00	264.00	266.00
FLOSS	Rect Femoris	Left	268.00	279.00	267.00
FLOSS	Rect Femoris	Left	286.00	273.00	270.00
FLOSS	Rect Femoris	Left	244.00	236.00	247.00
FLOSS	Rect Femoris	Left	257.00	261.00	259.00
FLOSS	Rect Femoris	Left	282.00	273.00	295.00
FLOSS	Rect Femoris	Left	279.00	259.00	291.00
FLOSS	Rect Femoris	Left	279.00	259.00	291.00
FLOSS	Rect Femoris	Left	275.00	266.00	274.00
FLOSS	Rect Femoris	Left	268.00	249.00	251.00
FLOSS	Rect Femoris	Left	333.00	293.00	311.00
FLOSS	Rect Femoris	Left	304.00	295.00	301.00
FLOSS	Rect Femoris	Left	266.00	248.00	245.00
FLOSS	Rect Femoris	Right	267.00	272.00	269.00
FLOSS	Rect Femoris	Right	295.00	264.00	290.00
FLOSS	Rect Femoris	Right	228.00	213.00	216.00
FLOSS	Rect Femoris	Right	254.00	269.00	262.00
FLOSS	Rect Femoris	Right	255.00	239.00	260.00
FLOSS	Rect	Right	248.00	257.00	276.00

	Femoris				
FLOSS	Rect Femoris	Right	272.00	247.00	274.00
FLOSS	Rect Femoris	Right	273.00	253.00	262.00
FLOSS	Rect Femoris	Right	252.00	252.00	246.00
FLOSS	Rect Femoris	Right	273.00	239.00	263.00
FLOSS	Rect Femoris	Right	268.00	256.00	272.00
FLOSS	Rect Femoris	Right	238.00	228.00	233.00
FLOSS	Rect Femoris	Right	256.00	245.00	269.00
FLOSS	Rect Femoris	Right	313.00	292.00	296.00
FLOSS	Rect Femoris	Right	245.00	232.00	225.00
FLOSS	Rect Femoris	Right	298.00	283.00	287.00
FLOSS	Rect Femoris	Right	287.00	282.00	288.00
FLOSS	Rect Femoris	Right	262.00	245.00	264.00
FLOSS	Rect Femoris	Right	258.00	253.00	246.00
FLOSS	Rect Femoris	Right	296.00	267.00	275.00
FLOSS	Rect Femoris	Right	281.00	271.00	276.00
FLOSS	Rect Femoris	Right	266.00	255.00	268.00
FLOSS	Rect Femoris	Right	314.00	291.00	304.00
FLOSS	Rect Femoris	Right	291.00	286.00	293.00
FLOSS	Rect Femoris	Right	291.00	286.00	293.00
FLOSS	Rect Femoris	Right	276.00	260.00	270.00
FLOSS	Rect Femoris	Right	255.00	247.00	256.00
FLOSS	Rect Femoris	Right	314.00	292.00	298.00
FLOSS	Rect Femoris	Right	306.00	296.00	303.00
FLOSS	Rect Femoris	Right	263.00	248.00	255.00
FLOSS	Vastus lt	Left	300.00	289.00	304.00

FLOSS	Vastus lt	Left	295.00	283.00	300.00
FLOSS	Vastus lt	Left	328.00	325.00	311.00
FLOSS	Vastus lt	Left	371.00	424.00	366.00
FLOSS	Vastus lt	Left	343.00	278.00	351.00
FLOSS	Vastus lt	Left	279.00	281.00	317.00
FLOSS	Vastus lt	Left	312.00	282.00	318.00
FLOSS	Vastus lt	Left	295.00	284.00	271.00
FLOSS	Vastus lt	Left	279.00	272.00	266.00
FLOSS	Vastus lt	Left	315.00	285.00	307.00
FLOSS	Vastus lt	Left	358.00	319.00	346.00
FLOSS	Vastus lt	Left	283.00	288.00	297.00
FLOSS	Vastus lt	Left	255.00	264.00	263.00
FLOSS	Vastus lt	Left	414.00	385.00	371.00
FLOSS	Vastus lt	Left	291.00	283.00	273.00
FLOSS	Vastus lt	Left	366.00	345.00	349.00
FLOSS	Vastus lt	Left	385.00	353.00	353.00
FLOSS	Vastus lt	Left	439.00	386.00	414.00
FLOSS	Vastus lt	Left	369.00	365.00	326.00
FLOSS	Vastus lt	Left	369.00	329.00	346.00
FLOSS	Vastus lt	Left	297.00	286.00	307.00
FLOSS	Vastus lt	Left	312.00	319.00	313.00
FLOSS	Vastus lt	Left	309.00	310.00	319.00
FLOSS	Vastus lt	Left	323.00	295.00	318.00
FLOSS	Vastus lt	Left	323.00	295.00	318.00
FLOSS	Vastus lt	Left	329.00	304.00	324.00
FLOSS	Vastus lt	Left	334.00	298.00	330.00
FLOSS	Vastus lt	Left	455.00	431.00	406.00
FLOSS	Vastus lt	Left	350.00	343.00	369.00
FLOSS	Vastus lt	Left	283.00	266.00	275.00
FLOSS	Vastus lt	Right	328.00	320.00	352.00
FLOSS	Vastus lt	Right	335.00	302.00	319.00
FLOSS	Vastus lt	Right	344.00	340.00	351.00
FLOSS	Vastus lt	Right	330.00	339.00	316.00
FLOSS	Vastus lt	Right	314.00	296.00	342.00
FLOSS	Vastus lt	Right	260.00	283.00	362.00
FLOSS	Vastus lt	Right	356.00	284.00	350.00
FLOSS	Vastus lt	Right	287.00	304.00	270.00
FLOSS	Vastus lt	Right	333.00	321.00	332.00
FLOSS	Vastus lt	Right	352.00	299.00	336.00
FLOSS	Vastus lt	Right	329.00	305.00	324.00
FLOSS	Vastus lt	Right	278.00	263.00	269.00
FLOSS	Vastus lt	Right	277.00	271.00	288.00
FLOSS	Vastus lt	Right	380.00	355.00	349.00
FLOSS	Vastus lt	Right	273.00	261.00	267.00
FLOSS	Vastus lt	Right	311.00	301.00	291.00

FLOSS	Vastus lt	Right	327.00	311.00	338.00
FLOSS	Vastus lt	Right	413.00	388.00	414.00
FLOSS	Vastus lt	Right	351.00	325.00	334.00
FLOSS	Vastus lt	Right	411.00	357.00	377.00
FLOSS	Vastus lt	Right	328.00	308.00	328.00
FLOSS	Vastus lt	Right	371.00	319.00	363.00
FLOSS	Vastus lt	Right	342.00	319.00	334.00
FLOSS	Vastus lt	Right	368.00	343.00	345.00
FLOSS	Vastus lt	Right	368.00	343.00	345.00
FLOSS	Vastus lt	Right	378.00	361.00	377.00
FLOSS	Vastus lt	Right	348.00	313.00	321.00
FLOSS	Vastus lt	Right	437.00	387.00	386.00
FLOSS	Vastus lt	Right	367.00	337.00	354.00
FLOSS	Vastus lt	Right	304.00	296.00	295.00
FR	Bic Fem c l	Left	337.00	336.00	439.00
FR	Bic Fem c l	Left	269.00	273.00	276.00
FR	Bic Fem c l	Left	273.00	270.00	272.00
FR	Bic Fem c l	Left	341.00	339.00	348.00
FR	Bic Fem c l	Left	212.00	219.00	226.00
FR	Bic Fem c l	Left	222.00	219.00	224.00
FR	Bic Fem c l	Left	287.00	286.00	290.00
FR	Bic Fem c l	Left	322.00	314.00	324.00
FR	Bic Fem c l	Left	320.00	315.00	323.00
FR	Bic Fem c l	Left	292.00	289.00	288.00
FR	Bic Fem c l	Left	304.00	315.00	308.00
FR	Bic Fem c l	Left	249.00	272.00	286.00
FR	Bic Fem c l	Left	342.00	319.00	351.00
FR	Bic Fem c l	Left	212.00	224.00	224.00
FR	Bic Fem c l	Left	208.00	215.00	204.00
FR	Bic Fem c l	Left	310.00	308.00	304.00
FR	Bic Fem c l	Left	319.00	331.00	332.00
FR	Bic Fem c l	Left	273.00	278.00	280.00
FR	Bic Fem c l	Left	327.00	331.00	326.00
FR	Bic Fem c l	Left	283.00	283.00	297.00
FR	Bic Fem c l	Left	274.00	269.00	283.00
FR	Bic Fem c l	Left	222.00	239.00	235.00
FR	Bic Fem c l	Left	337.00	338.00	323.00
FR	Bic Fem c l	Left	325.00	325.00	341.00
FR	Bic Fem c l	Left	276.00	280.00	304.00
FR	Bic Fem c l	Left	247.00	258.00	273.00
FR	Bic Fem c l	Left	289.00	298.00	310.00
FR	Bic Fem c l	Left	322.00	323.00	335.00
FR	Bic Fem c l	Left	391.00	418.00	385.00
FR	Bic Fem c l	Left	320.00	320.00	345.00
FR	Bic Fem c l	Right	333.00	359.00	356.00

FR	Bic Fem c l	Right	280.00	282.00	309.00
FR	Bic Fem c l	Right	401.00	293.00	369.00
FR	Bic Fem c l	Right	364.00	354.00	366.00
FR	Bic Fem c l	Right	227.00	235.00	235.00
FR	Bic Fem c l	Right	238.00	242.00	248.00
FR	Bic Fem c l	Right	298.00	304.00	299.00
FR	Bic Fem c l	Right	305.00	305.00	313.00
FR	Bic Fem c l	Right	329.00	333.00	338.00
FR	Bic Fem c l	Right	259.00	263.00	269.00
FR	Bic Fem c l	Right	305.00	310.00	317.00
FR	Bic Fem c l	Right	219.00	223.00	226.00
FR	Bic Fem c l	Right	295.00	302.00	299.00
FR	Bic Fem c l	Right	225.00	229.00	242.00
FR	Bic Fem c l	Right	219.00	214.00	231.00
FR	Bic Fem c l	Right	321.00	322.00	340.00
FR	Bic Fem c l	Right	305.00	331.00	315.00
FR	Bic Fem c l	Right	330.00	284.00	306.00
FR	Bic Fem c l	Right	328.00	320.00	310.00
FR	Bic Fem c l	Right	276.00	268.00	287.00
FR	Bic Fem c l	Right	286.00	273.00	293.00
FR	Bic Fem c l	Right	242.00	248.00	276.00
FR	Bic Fem c l	Right	314.00	342.00	331.00
FR	Bic Fem c l	Right	312.00	318.00	341.00
FR	Bic Fem c l	Right	297.00	289.00	298.00
FR	Bic Fem c l	Right	243.00	256.00	279.00
FR	Bic Fem c l	Right	313.00	308.00	330.00
FR	Bic Fem c l	Right	290.00	304.00	304.00
FR	Bic Fem c l	Right	343.00	324.00	357.00
FR	Bic Fem c l	Right	323.00	321.00	321.00
FR	Rect Femoris	Left	249.00	249.00	267.00
FR	Rect Femoris	Left	243.00	234.00	242.00
FR	Rect Femoris	Left	258.00	241.00	253.00
FR	Rect Femoris	Left	252.00	261.00	268.00
FR	Rect Femoris	Left	257.00	246.00	249.00
FR	Rect Femoris	Left	251.00	240.00	250.00
FR	Rect Femoris	Left	261.00	261.00	278.00
FR	Rect Femoris	Left	229.00	234.00	241.00
FR	Rect Femoris	Left	262.00	275.00	268.00

FR	Rect Femoris	Left	258.00	263.00	260.00
FR	Rect Femoris	Left	270.00	277.00	283.00
FR	Rect Femoris	Left	257.00	248.00	277.00
FR	Rect Femoris	Left	225.00	218.00	251.00
FR	Rect Femoris	Left	234.00	227.00	267.00
FR	Rect Femoris	Left	243.00	227.00	244.00
FR	Rect Femoris	Left	245.00	257.00	261.00
FR	Rect Femoris	Left	241.00	241.00	246.00
FR	Rect Femoris	Left	256.00	260.00	267.00
FR	Rect Femoris	Left	243.00	244.00	245.00
FR	Rect Femoris	Left	254.00	240.00	249.00
FR	Rect Femoris	Left	230.00	227.00	242.00
FR	Rect Femoris	Left	251.00	256.00	261.00
FR	Rect Femoris	Left	279.00	288.00	301.00
FR	Rect Femoris	Left	302.00	307.00	320.00
FR	Rect Femoris	Left	274.00	268.00	285.00
FR	Rect Femoris	Left	275.00	279.00	304.00
FR	Rect Femoris	Left	234.00	233.00	239.00
FR	Rect Femoris	Left	271.00	277.00	270.00
FR	Rect Femoris	Left	253.00	254.00	262.00
FR	Rect Femoris	Left	233.00	232.00	252.00
FR	Rect Femoris	Right	257.00	259.00	272.00
FR	Rect Femoris	Right	226.00	220.00	237.00
FR	Rect Femoris	Right	259.00	247.00	250.00
FR	Rect Femoris	Right	265.00	258.00	280.00

FR	Rect Femoris	Right	232.00	243.00	256.00
FR	Rect Femoris	Right	250.00	238.00	255.00
FR	Rect Femoris	Right	278.00	275.00	282.00
FR	Rect Femoris	Right	222.00	225.00	229.00
FR	Rect Femoris	Right	260.00	257.00	261.00
FR	Rect Femoris	Right	267.00	275.00	288.00
FR	Rect Femoris	Right	276.00	276.00	291.00
FR	Rect Femoris	Right	262.00	257.00	278.00
FR	Rect Femoris	Right	240.00	242.00	237.00
FR	Rect Femoris	Right	243.00	223.00	251.00
FR	Rect Femoris	Right	208.00	216.00	222.00
FR	Rect Femoris	Right	245.00	256.00	254.00
FR	Rect Femoris	Right	271.00	266.00	249.00
FR	Rect Femoris	Right	235.00	252.00	260.00
FR	Rect Femoris	Right	260.00	264.00	263.00
FR	Rect Femoris	Right	291.00	286.00	298.00
FR	Rect Femoris	Right	235.00	226.00	247.00
FR	Rect Femoris	Right	244.00	255.00	249.00
FR	Rect Femoris	Right	290.00	297.00	301.00
FR	Rect Femoris	Right	291.00	303.00	297.00
FR	Rect Femoris	Right	261.00	238.00	251.00
FR	Rect Femoris	Right	263.00	273.00	286.00
FR	Rect Femoris	Right	273.00	259.00	269.00
FR	Rect Femoris	Right	251.00	260.00	265.00
FR	Rect Femoris	Right	267.00	255.00	259.00

FR	Rect Femoris	Right	263.00	254.00	243.00
FR	Vastus lt	Left	315.00	303.00	324.00
FR	Vastus lt	Left	286.00	277.00	297.00
FR	Vastus lt	Left	263.00	269.00	288.00
FR	Vastus lt	Left	340.00	352.00	372.00
FR	Vastus lt	Left	298.00	284.00	307.00
FR	Vastus lt	Left	299.00	282.00	296.00
FR	Vastus lt	Left	333.00	331.00	356.00
FR	Vastus lt	Left	267.00	266.00	278.00
FR	Vastus lt	Left	303.00	305.00	317.00
FR	Vastus lt	Left	291.00	299.00	300.00
FR	Vastus lt	Left	305.00	327.00	355.00
FR	Vastus lt	Left	272.00	281.00	285.00
FR	Vastus lt	Left	254.00	248.00	278.00
FR	Vastus lt	Left	289.00	282.00	331.00
FR	Vastus lt	Left	309.00	300.00	330.00
FR	Vastus lt	Left	394.00	393.00	416.00
FR	Vastus lt	Left	363.00	396.00	352.00
FR	Vastus lt	Left	287.00	284.00	298.00
FR	Vastus lt	Left	287.00	284.00	275.00
FR	Vastus lt	Left	284.00	299.00	311.00
FR	Vastus lt	Left	262.00	276.00	281.00
FR	Vastus lt	Left	283.00	304.00	319.00
FR	Vastus lt	Left	329.00	338.00	356.00
FR	Vastus lt	Left	413.00	441.00	451.00
FR	Vastus lt	Left	362.00	336.00	402.00
FR	Vastus lt	Left	345.00	338.00	382.00
FR	Vastus lt	Left	283.00	287.00	304.00
FR	Vastus lt	Left	308.00	325.00	329.00
FR	Vastus lt	Left	304.00	313.00	320.00
FR	Vastus lt	Left	265.00	249.00	264.00
FR	Vastus lt	Right	342.00	313.00	355.00
FR	Vastus lt	Right	258.00	238.00	267.00
FR	Vastus lt	Right	260.00	289.00	288.00
FR	Vastus lt	Right	380.00	365.00	397.00
FR	Vastus lt	Right	299.00	288.00	321.00
FR	Vastus lt	Right	319.00	291.00	318.00
FR	Vastus lt	Right	293.00	300.00	308.00
FR	Vastus lt	Right	248.00	258.00	259.00
FR	Vastus lt	Right	351.00	322.00	341.00
FR	Vastus lt	Right	295.00	298.00	324.00
FR	Vastus lt	Right	307.00	331.00	352.00
FR	Vastus lt	Right	294.00	292.00	305.00
FR	Vastus lt	Right	271.00	275.00	310.00

FR	Vastus lt	Right	295.00	294.00	320.00
FR	Vastus lt	Right	334.00	316.00	358.00
FR	Vastus lt	Right	370.00	381.00	401.00
FR	Vastus lt	Right	317.00	324.00	293.00
FR	Vastus lt	Right	327.00	317.00	339.00
FR	Vastus lt	Right	293.00	272.00	263.00
FR	Vastus lt	Right	340.00	335.00	353.00
FR	Vastus lt	Right	287.00	277.00	304.00
FR	Vastus lt	Right	285.00	292.00	283.00
FR	Vastus lt	Right	333.00	344.00	368.00
FR	Vastus lt	Right	383.00	406.00	416.00
FR	Vastus lt	Right	332.00	307.00	323.00
FR	Vastus lt	Right	319.00	314.00	353.00
FR	Vastus lt	Right	299.00	318.00	345.00
FR	Vastus lt	Right	301.00	309.00	308.00
FR	Vastus lt	Right	327.00	317.00	344.00
FR	Vastus lt	Right	278.00	275.00	276.00