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Clinical Commentary/Current Concept Review

Tissue Flossing: A Commentary on Clinical Practice Recommendations

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Tissue flossing is an emerging myofascial intervention used by sports medicine professionals with a growing body of research evidence. Sports medicine professionals may use tissue flossing to increase myofascial mobility, improve joint ROM, enhance athletic performance, and reduce pain. Despite the increasing use, there is no consensus on clinical practice recommendations for this intervention. The purpose of this commentary is to discuss proposed clinical practice recommendations for tissue flossing and to encourage sports medicine professionals and researchers to contribute their expertise to further develop best practices.

Level of Evidence

5

INTRODUCTION AND BACKGROUND

Tissue flossing is an emerging myofascial intervention gaining popularity among sports medicine professionals since its introduction by Starrett and Cordoza in 2013.[1] The intervention consists of wrapping a latex tissue flossing band around a body region (joint or soft-tissue) using a 50% overlapping circumferential pattern (distal to proximal), with a relative stretch ranging from 50-90% of the band maximal length (Figures 1 and 2).[1-3] After applying the band, the individual performs up to an eight-minute treatment session that may include different active and passive movements of the wrapped body region.[1-5]

Tissue flossing has been used by sports medicine professionals to attempt to increase myofascial mobility, improve joint range of motion (ROM), enhance athletic performance, and reduce pain.[3-6] This intervention has also been explored as a method for performing blood flow restriction training.[7,8] Several companies manufacture tissue flossing bands, such as The Ready State™, RockTape®, and Rogue Fitness®, with most bands being constructed of latex rubber (1.5 mm thick) and available in 2 inch (5.08 cm) and 4 inch (10.16 cm) widths and an average length of 7 feet long (213.36cm).[2] Some manufacturers offer professional education on this technique, but most focus on the produc-

Figure 1. Tissue flossing band application to the thigh.

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Figure 2. Tissue flossing band application to the thigh.

tion and sale of the band products. Sports medicine professionals should consider that the tissue flossing bands may have different architectural properties, such as width and thickness, than other flat latex resistance bands (e.g., TheraBand® CLX™) commonly used for fitness and sports rehabilitation.[2,9,10]

The current body of evidence has grown over that past 10 years with several researchers reporting positive post intervention effects for joint ROM, muscle stiffness, muscle strength, pain reduction, and athletic performance.[3-5] Despite the growing popularity, there seems to be a lack of consensus regarding tissue flossing clinical practice recommendations such as indications, precautions, contraindications, and patient management during treatment. A review of the research evidence conducted in January 2024 (PubMed, PEDro, Science Direct, and EBSCOhost) did not reveal any manuscripts specifically discussing best practices for the use of tissue flossing bands.

The lack of evidence-based clinical practice recommendations creates a challenge for sports medicine professionals who use tissue flossing within their practice as well as for researchers studying the efficacy of this intervention in different populations. Therefore, the purpose of this commentary is to discuss proposed clinical practice recommendations for tissue flossing and to encourage sports medicine professionals and researchers to contribute their expertise to further develop best practice recommendations. Due to the lack of guidelines and emerging body of research evidence, this commentary integrates the tissue flossing research with existing clinical standards from other myofascial interventions as they relate to this discussion.[11,12] The following topic areas will be discussed: indications, precautions and contraindications, intervention description, patient assessment, patient monitoring, and band hygiene and care.

INDICATIONS

Currently, consensus has not been established on the optimal tissue flossing intervention parameters including amount of band stretch length, wrapping pattern, and total intervention time.[2] Despite the lack of universal agreement on optimal treatment parameters, the existing literature provides evidence that tissue flossing may improve joint ROM, muscle strength, athletic performance, and balance in specific situations, while also being a potential intervention to reduce musculoskeletal pain (Table 1).[3-6,13] It is important to note that selected studies were used to support the specific indications discussed and this commentary is not meant to serve as a comprehensive literature review or systematic analysis of the current body of research evidence. Sports medicine professionals are encouraged to review published systematic and scoping reviews that further appraise the tissue flossing research evidence.[3-5] Specific indications, related treatment parameters, and postulated mechanisms are discussed further in subsequent sections.

JOINT ROM, MUSCLE LENGTH, AND TISSUE STIFFNESS

Several researchers have documented short term post intervention changes in joint active ROM, passive ROM, and related muscle length (e.g., passive knee extension for hamstring length) after a tissue flossing intervention. For the ankle, researchers have documented post intervention changes in active ROM dorsiflexion and plantar flexion using manual goniometric or digital ROM devices among healthy adults[14,15] and recreational adult athletes.[16-19] Researchers have also documented post intervention changes in weightbearing lunge test performance among recreational adult athletes.[16,17,19,20]

For the knee, post intervention changes in quadriceps length (Ely's test) and hamstring length (active and passive knee extension tests, active straight leg raise test) have been documented among healthy adults.[21-23] For the lumbo-pelvic-hip complex, post intervention changes in hip flexion ROM have been documented via the active and passive straight leg raise test among healthy adults.[22,24,25] However, one study reported nonsignificant immediate post intervention changes for passive hip and knee ROM where the modified Thomas test was used to assess changes among healthy adults.[26]

For the upper extremity, researchers have documented short term post intervention changes in shoulder passive ROM (internal and external rotation) using a manual goniometer among adult amateur overhead athletes[27] and recreational adult athletes.[28] Researchers also documented the post intervention physical and perceptual changes in shoulder flexion passive ROM among healthy adults after a tissue flossing intervention that included the Child's Pose stretch (5 sets of 30 seconds).[29] Shoulder ROM was measured with a manual goniometer and a 6-point Likert scale (0 no change, 5 dramatic change) was used to document

Table 1. Tissue Flossing Recommendations

Description	*"tissue flossing is an intervention that uses a compressive latex band wrapped around a body region at a specific stretch length, followed by movement of the body region to manipulate the skin, myofascia, muscles, tendons, and/or joint structures."*
***Indications**	Impaired joint ROM (hip, knee, ankle, shoulder, sit and reach), muscle strength and power (hip, knee, ankle), athletic performance (vertical jump, sprint, hop distance, and jump landing), balance (static, dynamic), tissue stiffness (quadriceps, hamstrings, plantar flexors), Achilles tendinopathy, Keinbock's disease, Osgood-Schlatter's disease, shoulder pain, elbow pain, and delayed onset of muscle soreness.

*Indications: references provided in the written section; ROM: range of motion

perceived changes in ROM. The researchers reported non-significant post-intervention physical ROM changes; despite the lack of statistically significant physical improvement, participant's reported significant improvements in their perceived ROM.[29] The researchers postulated that the positive post intervention perception of ROM improvement may help individuals with better adherence to a treatment plan due the perceived progress. Further research is needed to confirm or refute these findings.[29]

Researchers have also documented the post intervention effects of tissue flossing on reducing tissue stiffness at the plantar flexors and ankle (measured via ultrasonography),[15,30,31] hamstrings (measured via ultrasonography),[22] and quadriceps (measured via tensiomyography)[32] and it has been postulated that changes in muscle tissue stiffness can influence joint ROM.[3]

In summary, the tissue flossing research on joint ROM, muscle length, and tissue stiffness has documented positive short term (up to 45 min) post intervention changes for healthy individuals and athletes after a single session. Researchers used tissue flossing interventions that included wrapping the joint (e.g., knee, ankle)[16,17,20,23,27-29,31] or soft-tissue (e.g., thigh, calf)[14,15,18-22,24,30,32] and various active (e.g., bodyweight squats, lunges, joint motion) and passive (e.g., child's pose stretch) movements for a total treatment time range of 2 minute to 8 minute. Several studies used a predetermined band stretch pressure ranging between 100mm Hg and 200mm Hg which was directly measured by different sub-band digital pressure sensors.[14,16,17,19,24,25] Other researchers only used the recommended stretch length (e.g., 50% band maximal length) and did not document any methods for measuring or monitoring band stretch pressure.[15,20,21,23,27-29] All studies used control comparison groups that included no intervention, tissue flossing band at different stretch lengths, instrument assisted soft-tissue mobilization (IASTM), self-myofascial rolling, kinesiology tape, or other interventions (e.g., dynamic or static stretching).[14,16,17,19-30,33,34]

MUSCLE AND ATHLETIC PERFORMANCE

Researchers have documented short-term post intervention changes after a tissue flossing intervention for lower extremity muscle strength and power. For the ankle, several studies have documented post intervention changes in ankle dorsiflexion and plantar flexion strength and power measured by isokinetic dynamometry among healthy adults[14] and recreational adult athletes.[15] One study also documented decreased soleus H-reflex activity (up to 10 min) after a tissue flossing intervention.[33] For the knee, several studies have documented post intervention changes in knee flexion and extension strength measured by isokinetic dynamometry among healthy adults,[15,23,26] However, nonsignificant post intervention changes for knee flexor and extensor strength measured by isokinetic dynamometry were also found.[35] For the upper extremity, researchers have documented post intervention changes in shoulder isokinetic strength (internal and external rotation) and power among adult amateur overhead athletes[27] and power among recreational adult athletes.[28] Researchers that conducted strength testing used a combination of measures such as isokinetic maximum voluntary contraction, maximum eccentric contraction, rate of force development, and peak torque.[14,15,23,26,33,35] Researchers also measure power with the one arm shot put test[27] and bench press test with an 3D accelerometer.[28]

Researchers have also documented short term post intervention changes in specific athletic performance measures after a tissue flossing intervention. For counter movement jump performance, researchers reported post intervention changes after a tissue flossing intervention to the ankle and knee among recreational adult athletes[16,17,30] and professional adult rugby players.[34] Researchers used digital force plates or mats to document participant performance for these investigations.[16,17,30,34]

For sprint performance, researchers have also documented short term post intervention changes after tissue flossing to the ankle among recreational adult athletes[16,30] and professional adult rugby players.[34] The researchers used different digital speed timing systems to document participant performance in these investigations.[16,30,34] Researchers have also documented post intervention changes in static and dynamic balance, hop distance, and jump landing performance among healthy adults using the Biodex isokinetic dynamometer (Biodex System, Shirley, NY, USA), Y-Balance test, Landing Error Scoring System (LESS), and single-leg triple hop test.[21,23] However, some researchers reported nonsignificant post intervention changes in counter movement jump performance as measured by a force plate.[26,32]

In summary, the research on muscle and athletic performance has documented positive short term (up to 60 min) post intervention changes after tissue flossing. Researchers used tissue flossing interventions that included wrapping the joint (e.g., knee, ankle)[16,17,23,26,30,33,34] or soft-tissue (e.g., thigh, calf)[14,15,21,24,26,33,35] and various active movements (e.g., joint motion) for a total treatment

time range of 2 minutes to 8 minutes. Several studies used a predetermined band stretch pressure ranging between 100mm Hg and 200mm Hg which was directly measured by different sub-band digital pressure sensors.[14,16,17,19,24,25,34] Other researchers only used the recommended stretch length (e.g., 50% band maximal length) or used a handheld dynamometer (measured band stretch force) and did not document any methods for measuring or monitoring band stretch pressure during the intervention.[15,20,21,23,27-29,32,36] All studies used control comparison groups that included no intervention, cotton elastic bandage, tissue flossing band at different stretch length pressures, IASTM, self-myofascial rolling, kinesiology tape, or other interventions (e.g. dynamic or static stretching).[14-16,19,21-24,26-30,33,34,36]

DELAYED ONSET OF MUSCLE SORENESS

Researchers have studied the short term effects of a tissue flossing intervention on delayed onset of muscle soreness (DOMS) after strenuous exercise. For the upper extremity, one research group documented decreased post intervention DOMS (up to 48 hours) in healthy adults after a tissue flossing intervention as documented using the 100-mm Visual Analog Scale (VAS).[37] For the lower extremity, another group did not find any significant changes in DOMS after a tissue flossing intervention among healthy adults as documented using the numeric pain rating scale (0-10).[38] When considering possible physiological mechanisms, researchers postulated that tissue flossing compression may have reduced the inflammatory response that accompanies the muscle microdamage from DOMS and may have lowered intracellular osmotic pressure that may reduce nociceptor sensitivity.[37]

In summary, the two available studies on tissue flossing for DOMS produced mixed results. Both studies used a tissue flossing band intervention that wrapped the soft tissue (e.g., upper arm, upper thigh) and included various active movements (e.g., joint motion) for a total treatment time range of 2 minutes to 6 minutes. Researchers only used the recommended band stretch length (e.g., 50% band maximal length) and did not document any methods for measuring or monitoring band stretch pressure.[37,38] Both studies used a non-treatment control comparison groups.[37,38] Sports medicine professionals should consider the few studies on this topic and the limitations of each study when considering tissue flossing for the treatment of DOMS.

SPECIFIC INJURIES AND PAIN

Researchers have published different case studies and clinical studies that suggest a tissue flossing intervention may help reduce pain, improve function, and improve lower extremity muscle endurance and power for specific conditions. Favorable results of tissue flossing for Achilles tendinopathy,[39] Keinbock's disease,[40] and Osgood-Schlatter's disease[41] have been reported in case reports on adolescent and adult athletes. All case reports used tissue flossing as their primary treatment except for the case study on Achilles tendinopathy which used a combined tissue flossing and self-myofascial release (e.g., lacrosse ball) intervention.[39] These case reports used outcome measures such as visual analog pain scale, pressure pain threshold algometry, lower extremity functional scale (LEFS), Wrist/Hand Disability Index (WHDI), maximal repetition single leg squat, and standing long jump to measure treatment outcomes.[39-41] For each patient case, total treatment duration ranged from two to six weeks.[39-41]

Clinical studies have also been conducted that document post intervention changes in pain after a tissue flossing intervention. One researcher group reported post intervention improvements in elbow pain measured by the VAS.[13] Another research group reported post intervention improvements in knee pain measured by the VAS, pressure pain threshold algometry, and Short Form McGill Pain Questionnaire II.[42]

In summary, the research on tissue flossing for specific injuries and pain has documented post intervention changes for pain, function, and muscle performance. However, the evidence is mixed among different case and clinical studies.[13,39-42] Several studies used a tissue flossing intervention that wrapped the joint (e.g., wrist, elbow)[13,40,42] and soft tissue (e.g., upper arm, upper thigh)[39,41] and included various active movements (e.g., joint motion) for a total treatment time range of 2 minutes to 6 minutes. For all studies, researchers only used the recommended tissue floss band stretch length (e.g., 50% band maximal length) and did not document any methods for measuring or monitoring band stretch pressure during the intervention.[13,39-42] The clinical studies used one group of participants without a controlled comparison group.[13,42]

INTERCHANGEABILITY

Three studies have documented the potential interchangeability of a tissue flossing intervention with other myofascial interventions. One research group[43] found that tissue flossing, self-myofascial rolling, and IASTM (applied by a professional) equivalently increased short term post intervention knee joint passive ROM. Researchers also reported similar post intervention changes with IASTM (applied by a professional) and tissue flossing on ankle passive ROM after a four week intervention (two sessions per week).[44] Another research group reported similar post intervention changes with tissue flossing and a self-myofascial rollers on Achilles stiffness (measured by a myotonometry device), countermovement jump, and sprint performance.[30]

In summary, the emerging research suggests that tissue flossing may be interchangeable with IASTM and self-myofascial rolling for improving knee and ankle joint ROM and triceps surae stiffness.[30,43,44] Tissue flossing and self-myofascial rolling may also improve countermovement jump and sprint performance.[30] Studies used a tissue flossing intervention that wrapped the joint (e.g., ankle)[44] or soft tissue (e.g., thigh)[30,43] and included various active movements (e.g., joint motion) for a total treatment time range of 2 minutes to 5 minutes. For all studies, researchers only used the recommended tissue floss band stretch length (e.g., 50% band maximal length) and did not document any methods for measuring or monitoring band stretch pressure. All studies used matched intervention times for the

comparison groups.[30,43,44] While similar results were reported across interventions, sports medicine professionals should also consider individual patient needs and situations, as well as clinical considerations (e.g., contraindications), when selecting between these interventions.

TREATMENT PARAMETERS

Sports medicine professionals should consider that many different treatment parameters noted among the aforementioned studies included but were not limited to a single treatment session, a 50% overlap of the band on the tissues or joint, different wrapping patterns (e.g., circumferential, figure 8), preset band stretch length (e.g., 50%-75% maximal length) or stretch pressure (e.g., 100 to 200 mmHg), active movements, passive movements, and a treatment duration ranging from 2 minutes to 6 minutes or exercise repetition range from 10 to 30 repetitions.[3-5] To date, no consensus has been reached on the optimal treatment parameters for specific patients of conditions. The sports medicine professional will have to translate the existing research evidence to their practice and match the best parameters to each patient.

PHYSIOLOGICAL MECHANISMS

Researchers have postulated different physiological mechanisms for the post intervention changes observed with tissue flossing.[3-6] For *joint ROM & tissue stiffness*, researchers have hypothesized that tissue flossing may increase muscle stretch tolerance, reduce muscle stiffness, and improve myofascial thixotropy.[3-6] For *muscle and athletic performance*, researchers have postulated that a tissue flossing intervention may enhance hormonal responses, reflex facilitation, and overall neuromuscular function.[3] Researchers have also postulated that these effects may occur from the potential vascular occlusion from the tissue band stretch pressure or from a physiological response once the band is released.[14,16] Researchers have also theorized that ischemic preconditioning (e.g. tissue flossing) may improve athletic performance.[20] Tissue previously submitted to ischemic conditions may become more resistant to ischemia and its negative effects.[45] For *DOMS*, researchers have hypothesized that immediate application of tissue flossing after strenuous exercise may reduce inflammation, intracellular osmotic pressure, and nociceptor sensitivity.[3,37] For *specific injuries and pain*, the mechanism behind patient recovery may be multifactorial making it difficult to suggest a specific mechanism for the effects of a tissue flossing intervention and researchers have not provided specific discussions regarding potential physiological mechanisms in prior research.[3,39-42] For *interchangeability*, preliminary research has suggested that tissue flossing may produce similar mechanical and neurophysiological effects as other myofascial interventions, such as IASTM, kinesiology tape, and self-myofascial rolling. Researchers have documented positive post-intervention changes in knee flexion,[43] ankle dorsiflexion,[44] Achilles stiffness,[30] and athletic performance[34] when all three myofascial interventions were compared.

In summary, several researchers have postulated different post intervention physiological effects from tissue flossing. To date, these theories have not been fully validated and remain under study.[3-6,14,16,20] The sports medicine professional should consider the lack of understanding of mechanism(s) by which effect occur and the need for further investigations on the physiological effects of tissue flossing for different patient populations and medical conditions. This may be most applicable to sports medicine professionals who use tissue flossing to achieve a specific post intervention physiological change with their patients.

PRECAUTIONS AND CONTRAINDICATIONS

Currently, a universal consensus on tissue flossing precautions and contraindications is lacking. Starrett and Cordoza[1] documented a few conditions in their book, such as abnormal sensation (e.g., numbness or tingling or pin and needles), inadequate arterial and vascular function (e.g., skin turns cyanotic), or an abnormal feeling of claustrophobia around the band and body region. Since their book was published, there have been no other available peer-reviewed commentaries or studies on proposed tissue flossing precautions and contraindications. This section will provide suggested precautions and contraindications based upon Starrett and Cordoza[1] and adapted from other myofascial interventions that have published guidelines (Tables 2 and 3).[11,12]

The sports medicine professional should consider that some common conditions or clinical presentations may be considered as either precautionary or contraindicative depending on the patient. In the presence of such conditions, sports medicine professionals should conduct a comprehensive clinical examination to determine if tissue flossing is safe for these individuals, and what might constitute a precaution or contraindication depending on the patient. While an all-inclusive list is outside of the scope of this commentary, sports medicine professionals and researchers should be aware of common conditions or clinical presentations that may need to be considered prior to or during a tissue flossing intervention. This may include but are not limited to latex allergy, arterial and vascular inhibited function before or during treatment, abnormal sensations during treatment, fragile or sensitive skin, connective tissue disorders, congestive heart disease/circulatory disorders, cancer, pregnancy, patient intolerance, hypersensitivity, high pain sensation due to injury, peripheral vascular disease or insufficiency, varicose veins, lymphedema, tissue edema/swelling , medications that thin blood or alter sensation, diabetes, neuropathy or polyneuropathy, and hypertension.

In summary, this section proposes possible precautions and contraindications for consideration. It is anticipated that the discussed conditions and clinical presentations will be modified to provide evidence-based guidelines with future research and lessons learned from clinical practice. Tables 2 and 3 provide a more thorough list of suggested precautions and contraindications for consideration when using tissue flossing bands.

Table 2. Precautions for Tissue Flossing

• Latex allergy	• Arterial and vascular inhibited function during treatment (e.g., cyanotic skin)
• Abnormal sensations during treatment (e.g., numbness)	• Patient intolerance, hypersensitivity, high pain sensation due to injury.
• Fragile or sensitive skin	• Connective tissue disorder
• Varicose veins or burn scars	• Medications that thin blood or alter sensations
• Acute inflammatory conditions	• Lymphedema or tissue edema or swelling
• Cancer	• Pregnancy
• Hypertension	• Osteoporosis
• Unhealed closed or non-complicated fractures	• Rheumatoid arthritis, ankylosing spondylitis
• Post injection (e.g., steroid)	• Diabetes, neuropathy, or polyneuropathy
• Congestive heart disease, circulatory disorders	• Direct pressure over face, eyes, arteries, veins, or nerves
• Kidney dysfunction	• Pacemaker or insulin pumps (treatment around devices)
• Body art	• Insect bite of unexplained origin

Table 3. Contraindications for Tissue Flossing

• Latex allergy	• Arterial and vascular inhibited function during treatment (e.g., cyanotic skin)
• Abnormal sensations during treatment (e.g., numbness)	• Patient intolerance, hypersensitivity, high pain sensation due to injury.
• Fragile or sensitive skin	• Connective tissue disorders (e.g., Ehlers-Danlos syndrome, Marfan's syndrome)
• Skin rash, open wounds, blisters, local tissue inflammation, burn scars, or tumors	• Acute injury or infection (viral or bacterial), fever, or contagious condition
• Peripheral vascular disease or insufficiency, varicose veins	• Medications that thin blood or alter sensations
• Acute inflammatory conditions	• Lymphedema or tissue edema or swelling
• Cancer or malignancy	• Pregnancy (e.g., over abdomen)
• Hypertension (controlled or uncontrolled)	• Osteoporosis (advanced)
• Unhealed or unstable bone fracture	• Rheumatoid arthritis, ankylosing spondylitis
• Hematoma, myositis ossificans	• Diabetes, neuropathy, or polyneuropathy
• Acute or severe cardiac, liver, or kidney disease	• Congestive heart disease, circulatory disorders
• Neurologic conditions resulting in loss or altered sensation (e.g., Multiple Sclerosis)	• Bleeding disorders (Hemophilia)
• Medications that thin blood or alter sensations.	• Thrombophlebitis or osteomyelitis
• Recent surgery or injury or unhealed surgical site	• Direct pressure over face, eyes, arteries, veins, or nerves
• Pacemaker or insulin pumps (treatment around devices)	• Autoimmune disorders, reflex sympathetic dystrophy, or complex regional pain syndrome

INTERVENTION DESCRIPTION

Over the past 10 years, sports medicine professionals, researchers, and manufacturers have used different names to classify this intervention such as tissue flossing,[3,5,13,16,17,21,22,24-26,32-37] compression tissue flossing,[4] voodoo floss,[29] ankle flossing,[31] floss bands,[5,7,14] and Rockfloss®.[2] To date, no formal description of tissue flossing has been proposed in the body of research evidence. Given the diversity of nomenclature, tissue flossing needs to have a

Table 4. Tissue Flossing Outcome Measures

Patient Reported Outcomes	**Pain/Delayed Onset of Muscle Soreness:** • Visual analog pain scale,[37] numeric pain scale,[38] Short Form McGill Pain Questionnaire II.[42] **Function/Disability:** • Lower Extremity Function Scale[39] and Wrist/Hand Disability Index[40]
Joint ROM, Muscle Length, and Tissue Stiffness	**Joint ROM:** • Manual goniometer and digital ROM devices[14-19,27,28] • Weight bearing lunge test[16-20] **Muscle Length:** • *Knee:* Ely's test, active and passive knee extension tests[21-23] • *Lumbo-pelvic-hip complex:* active and passive straight leg raise test, sit and reach test, modified Thomas test[22,24-26] • *Tissue stiffness/blood flow:* ultrasonography,[15,22,30,31] tensiomyography,[32] myotonometry,[35] acoustic radiation force impulse,[10] and power doppler sonography[10]
Muscle and Athletic Performance	**Muscle Performance:** • **Strength/Power:* Isokinetic dynamometry[14,15,23,26-28,33,35] • *Neuromuscular activity:* soleus h-reflex[33] **Athletic Performance:** • *Counter movement jump:* digital force plates or mats[16,17,30,34] • *Sprints:* digital speed timing systems[16,30,34] • *Hop distance:* single leg triple hop test, standing long jump[21,23,41] • *Jump landing:* Landing error scoring system[21] • *Dynamic balance:* Y-balance test, Biodex Isokinetic dynamometer[21,23]

*Strength/Power: Testing included isokinetic maximum voluntary contraction, maximum eccentric contraction, rate of force development, and peak torque.

working description to clearly communicate the intervention to fellow sports medicine professionals, other healthcare providers, researchers, and patients. Furthermore, a working description may provide a clear understanding of the intervention and may prevent confusion between tissue flossing and other interventions. Therefore, the authors propose the following working description of tissue flossing: "*tissue flossing is an intervention that uses a compressive latex band wrapped around a body region at a specific stretch length, followed by movement of the body region to manipulate the skin, myofascia, muscles, tendons, and/or joint structures.*"

In summary, the existing body of tissue flossing research evidence lacks a clear description of the intervention. The proposed tissue flossing description is novel and should be considered a work-in-progress that can be updated over time as the knowledge and research in this area grows (Table 1).

PATIENT ASSESSMENT

Sports medicine professionals should use outcomes measures to assess the efficacy of their tissue flossing band intervention on their patients. Researchers have used different patient reported outcomes (PROs) and clinical outcomes to measure the post intervention changes of this intervention.[3-5] These outcomes and related research were discussed in the prior section on indications for tissue flossing. Table 4 provide a summary of common outcomes used in those studies with the related references.

In summary, sports medicine professionals should consider using similar PROs and clinical outcomes to measure the post treatment effects of their tissue flossing intervention. There is always a need to translate the research evidence into clinical practice to optimize treatment results. Researchers would benefit from the use of outcomes from clinical practice to inform future research questions and study design. The outcome measures noted in this discussion have been used by tissue flossing researchers and may fit well into clinical practice.[3-5]

PATIENT MONITORING

Sports medicine professionals should consider the importance of monitoring the amount of tissue flossing band stretch pressure and the patient's response during application. Several researchers have studied the efficacy of a tissue flossing intervention at various band stretch lengths measured as pressure (e.g., 100 to 295 mm Hg) or general intensity (e.g., from "low" to "high" tension).[7,8,14,16-18,24,26,32,33] Researchers used ultrasound imaging (Philips iU22 Ultrasound, Bothell, WA, USA) to monitor limb occlusion pressure and hemodynamic responses during the intervention.[8] Researchers have also used different pressure devices under the tissue floss band such as the PicoPress™ pressure sensor (Microlab Ellettronica Sas, Italy),[32] Kikuhime™ pressure monitor (TT MediTrade, Sorø, Denmark),[16,17,33,34] Tekscan pressure sensor (Tekscan, South Boston, MA),[24] AMI pressure sensor device (AMI Techno., Ltd. Japan),[15,22] an adapted sphygmomanometer (generic),[26] and a homemade pressure monitor using a bulb, valve, and plastic tube.[14]

Researchers have suggested that a tissue flossing intervention with low stretch pressure (100 to 150 mm Hg; based upon thigh circumference) may produce short term post intervention improvements in joint active ROM and muscle strength.[14,25] Consequently, research groups studying

different tissue flossing band stretch pressures have documented adverse effect (e.g., pain, numbness, loss of ROM, decreased strength) with high band pressure (e.g., ⩾ 200 mm Hg).[3,14] Another group of researchers[46] measured the blood supply to the biceps brachii using the Précisé 8008 (Ulrichstein, Germany) and documented an unusual physiological response. The researchers measured before and after a 2-minute tissue flossing intervention based upon a prior published protocol (e.g., 50% overlapping, 30-60% maximum band length) with no monitoring of stretch pressure.[46] The researchers documented a large depression of blood perfusion to the biceps brachii after the intervention which was opposite of their expectations of a rapid perfusion of blood to the area.[46] The researchers suggested that tissue flossing should be administered with caution and monitored due to these potential effects and until further validation research is conducted. Some researchers have explored the use of tissue flossing as a method of blood flow restriction training.[7,8]

Currently, there are no standard guidelines or methods to monitor and measure tissue flossing stretch pressure during application (e.g., soft tissue or joints) without having some digital or adapted pneumatic device.[8] Some researchers have tried to use a patient reported numeric perceived tightness scale (0-10) but found that it was unreliable to track and document stretch pressure.[47] Cheatham and Baker[2] developed an exploratory clinical method to measure tissue flossing band tension force (Newtons) at different band elongation lengths. Their study methodology provided a simple way to quantify and document a tissue flossing intervention using band strength length and force. Other researchers[7,23] have replicated these testing methods and documented favorable results. However, this quantification method still needs to be fully validated because sports medicine professionals and researchers may require an external device to monitor and measure band stretch pressure during treatment.

In summary, sports medicine professionals should consider the patient safety implications when using a tissue flossing band at different stretch lengths because the pressure cannot be measured without using a monitoring device.[3] Researchers have suggested that higher band stretch pressure may create some injury risks, if not properly monitored. It appears that low stretch pressure may be the safest approach along with proper patient monitoring.[3] The research noted in this section does have limitations but clearly alludes to the importance of patient safety. Observing the patient's response and measuring band stretch pressure with a monitoring device may be the best method to ensure patient safety. Further research is warranted in this area.

HYGIENE AND CARE

Tissue flossing band hygiene is another clinical practice consideration that has not been discussed in the body of research evidence. A recent search revealed no published studies or commentaries on this topic. Other myofascial interventions, such as self-myofascial rolling and IASTM have suggested published recommendations for hygiene practices.[11,12] The following section will provide recommended cleaning and care practices for latex tissue flossing bands. These recommendations are adapted from published cleaning recommendations from the Center for Disease Control (CDC) and a major manufacturer of latex resistance bands.[48,49]

Based upon the CDC guidelines, tissue flossing bands would be considered a non-critical item (e.g., gym equipment) as the bands are in contact with intact skin and no mucous membranes or other sterile tissues.[50,51] Non-critical items generally require an Environment Protection Agency (EPA) approved low-level chemical disinfectant to clean.[49,51] The following proposed recommendations are a starting point to develop best practice standards for tissue flossing band hygiene and care. *For general cleaning*, it is recommended to hand wash the band with mild soap and water and avoid strong detergents. The band should not be cleaned and dried in a washing machine or dryer. The tissue flossing band should lay flat when drying and talcum powder can be applied when dry. If chlorinated water is used, the band should be rinsed with clean water and talcum powder applied when dry. *For disinfecting*, it is recommended to use a lactic acid-based sanitizer (e.g., Clorox EcoClean™) or a product based on colloidal silver (e.g., Silver Guard®).[48,50] Alcohol based sanitizers should not be used because they can degrade the band.[48] *For storage*, it is recommended to store the band in a temperature-controlled area between 40-110° F (5 to 45° C) with less than 95% relative humidity and to avoid exposing the band to direct sunlight and contact with oils, solvents, or grease.[48]

Other recommended best practices include but are not limited to each patient having their own tissue flossing band/s, teaching patients how to care for their band/s, following manufacturer cleaning guidelines, and wearing the appropriate personal protective equipment (e.g., gloves, mask) during cleaning or disinfecting.[48]

In summary, the sports medicine professional should consider these hygiene and care recommendations as a starting point for best practices. Sports medicine professionals should have written hygiene and care guidelines for their work setting and for patients to ensure proper care of the tissue flossing bands.

CLINICAL IMPLICATIONS

This commentary provides a framework for the development of tissue flossing clinical standards and recommended best practices. The lack of clinical practice recommendations creates a challenge for sports medicine professionals and researchers. Sports medicine professionals may default to using their own preferred tissue flossing band intervention methods versus evidence-based sources. Researchers may also use unique methodology in their investigations that do not build on the existing body of evidence, creating a gap and making it challenging to determine best practices to maximize treatment effect.[3-6] The following section provides a summary of key points from this commentary.

INDICATIONS

Researchers have documented post intervention changes from tissue flossing for different indications while a small amount have documented nonsignificant results.[3-5] When interpreting these results, sports medicine professionals should also consider the variations in study methodology including sample population, sample size, treatment application (e.g., treatment parameters), treatment location (e.g., soft tissue or joint), manufactured tissue floss bands, main study outcome measures (e.g., weight-bearing lunge test, knee flexion ROM), and short-term investigations. For example, the reported treatment effect sizes have often been classified as small to medium for joint ROM, indicating the overall effect of tissue flossing may be limited.[3-6] However, the reported treatment effect sizes varied by study and intervention location and measures,[3-5] further emphasizing the need for a clear description of the intervention and well-designed research with clear and consistent outcomes to establish a sound body of research evidence. Overall, the body of research evidence is still emerging with a need for higher quality research and more longitudinal investigations.

PRECAUTIONS AND CONTRAINDICATIONS

Currently, there is no consensus on precautions and contraindications for a tissue flossing intervention. The precautions and contraindications noted in this commentary are not all inclusive but a starting point for sports medicine professionals and researchers to consider when using tissue flossing with different patients. It is important to note that some medical conditions or clinical presentations can be both a precaution and contraindication depending on the patient. Sports medicine professionals and researchers should always consider patient safety when using tissue flossing within their clinical practice or research study.

INTERVENTION DESCRIPTION

Currently, there is no consensus among sports medicine professionals and researchers on a clear description of tissue flossing. This has produced different terms in the nomenclature without a clear description of the intervention. The proposed working description is a starting point. Sports medicine professionals and researchers are encouraged to build upon this working description by refining and updating these topics as the body of knowledge grows in this area.

Sports medicine professionals and researchers should follow methodological reporting guidelines, such as the Consensus on Exercise Reporting Template (CERT) to document their tissue flossing intervention. The CERT provides an organized process of reporting clinical exercise interventions using a 16-item checklist (in seven categories).[52] Key sections of the checklist include but are not limited to *what* materials (e.g., equipment) were used, *who* provided the intervention, *how* was it delivered, *location* (e.g., setting), and *when and how much* (e.g., dosage) of the intervention. The CERT checklist is often used in conjunction with more comprehensive reporting guidelines (e.g., CONSORT statement for randomized controlled trials.).[53] The use of reporting guidelines to guide the description of tissue flossing methodology will enhance technique replication and our understanding of treatment effectiveness.[52,53]

PATIENT ASSESSMENT

Researchers have used different tissue flossing PROs and clinical measures in their investigations. Sports medicine professionals are encouraged to integrate such patient and clinical measures (presented in Table 4) into their practice, with an emphasis on selecting valid measures relevant to the specific patient and situation. This may help with documenting and tracking the efficacy of the tissue flossing intervention. There is a need to translate research to clinical practice and using such outcome measures will assist in this process.

PATIENT MONITORING

Currently, there are no evidence-based guidelines or best practices for patient safety monitoring during a tissue flossing intervention. There may be a risk for injury with higher levels of band stretch pressure. Sports medicine professionals may need to monitor both the patient's response and amount of band stretch pressure using a monitoring device during application.[3,14]

HYGIENE AND CARE

Tissue flossing band hygienic practices and care have not been documented in the research evidence. The suggested best practices are a starting point for sports medicine professionals and researchers. Tissue flossing bands (made of latex) require unique cleaning and care procedures when compared to other myofascial interventions such as self-myofascial rollers or IASTM instruments.[11,12] Perhaps, the best hygiene and care strategy is to encourage patients to have their own set of tissue flossing bands and follow manufacturer recommendations for tissue band hygiene and care.

CONCLUSION

This clinical commentary discusses proposed tissue flossing clinical practice recommendations for indications, precautions and contraindications, intervention description, patient assessment, patient monitoring, and band hygiene and care. Sports medicine professionals and researchers should consider this commentary as a starting point for further developing such standards and recommended best practices for tissue flossing.

CONFLICT OF INTEREST

The authors report no conflict of interest with the subject of this manuscript.

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