A REVIEW OF THE EFFECTS OF KINESIO TAPING® FASCIAL CORRECTION TECHNIQUE OF THE ILIOTIBIAL BAND RELATING TO MYOFASCIAL PAIN SYNDROME

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Austin James Hills

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SUPERVISORY COMMITTEE:

Dr. Yeong Rhee
Chair

Dr. Kyle Hackney

Ronda Peterson

Approved:

January 3, 2023
Date

Dr. Yeong Rhee
Department Chair

ABSTRACT

This paper reviewed the effects of Kinesio Taping® on pain pressure threshold (PPT) of trigger points (TrPs) within the iliotibial band (ITB). The condition known as myofascial pain syndrome (MPS) is a chronic pain disorder where pressure or sensitive points in muscle tissue causes localized or referred pain. This disorder typically manifests chronically due to an overuse or overtraining mechanism. MPS has been identified in individuals of all ages, body types, and activity level. However, the population with the highest reported prevalence is individuals participating in moderate or higher levels of physical activity. Kinesio Taping® fascial correction technique claims an effective intervention for MPS and associated TrPs. The outcome measure most frequently reported to have statistically significant positive correlation to Kinesio Taping® treatment is patient perceived pain. Kinesio Taping® studies vary greatly in subject population characteristics, study design, and methodology. Further research is required for proper clinical recommendations to be made.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ACh .... Acetylcholine

ANOVA .... Analysis of Variance

BT .... Botulinum Toxin

CKTP® .... Certified Kinesio Tape Practitioner®

EMG... Electromyography

IR.. Internal Rotation

ITB .... Iliotibial Band

ITBS... Iliotibial Band Syndrome

LTR .... Local Twitch Response

MMG .... Mechanomyography

MPR .... Manual Pressure Release

MPS .... Myofascial Pain Syndrome

NSAIDs... Non-Steroidal Anti-Inflammatory Drugs

PPT... Pain Pressure Threshold

ROM .... Range of Motion

TFL .... Tensor Fasciae Latae

TrP(s) .... Trigger Point(s)

UT .... Upper Trapezius

VAS .... Visual Analogue Scale

1. INTRODUCTION

1.1. Overview of the Topic

Myofascial pain syndrome (MPS) is a common soft tissue condition, and it presents as a dull pain in muscles or connective tissue.[1–4] The syndrome typically occurs because of stress-related muscular tension caused by repetitive contractile forces. MPS can affect any individual regardless of age, sex, or activity level. Trigger points (TrPs) are common findings among the athletic population due to the biomechanical requirements of sport performance which puts the athlete at risk to develop friction syndromes and general soft tissue restriction[3,5–11]. These myofascial TrPs can often be found in the iliotibial band (ITB). The nodules within the taut band, when palpated, often cause patient-perceived painful symptoms.[1,2,12]

MPS in the ITB can cause referred pain in the acetabulofemoral joint, inferiorly in the anterolateral thigh and most commonly, the lateral knee.[13] This irritation of the lateral knee can lead to a condition called Iliotibial Band Syndrome (ITBS), which can affect normal walking gait, cause physical limitations, and be painful during activities of daily life. It is important for clinicians treating orthopedic injuries to be aware of the potential causes and symptoms of MPS.

Kinesio Taping® is a treatment option that has been used by a variety of medical professionals and for many orthopedic conditions since its creation in 1973 by Dr. Kenzo Kase.[14] Dr. Kase and his team of researchers have developed a variety of tape applications, all of which are theorized to produce different therapeutic outcomes. Kinesio® tape that is stretched and applied at more than 50% of its original length is hypothesized to provide supportive effects and is often used for joint applications.[14] Kinesio® tape can also be applied in a manner to facilitate muscle function; such that the tape is applied in the direction from muscle origin to insertion and is stretched to 15-35% of its original length.[14] Kinesio® tape was designed to cause folds in the skin's most superficial layers. The design creates space between the skin and the underlying fascia, producing therapeutic effects, such as joint repositioning, lymphatic drainage, and pain reduction[15]. Kinesio® tape has inconsistencies in the literature, and with multiple brands competing for the share of the sports' tape market, it is important for their claims to be supported by evidence-based recommendations.

1.2. Statement of Purpose

The purpose of this review is to determine the effect of Kinesio Taping® fascial correction on subjective pain pressure threshold of palpable ITB trigger points in individuals diagnosed with MPS.[22–26]

1.3. Brief Review of Literature

The research focused on evaluating the causes and solutions to ITBS and MPS span a few decades, however, only in more recent years have the findings of fascial corrective studies shown promising results. The emergence of new technologies and treatments for these pain syndromes has led to a flood of new research that has some interesting new findings.[3,4,13,27,28] Halski et al. published a study titled "Short-Term Effects of Kinesio Taping and Cross Taping Application in the Treatment of Latent Upper Trapezius Trigger Points" and explored the use of the Kinesio Taping® space correction method.[29] The researchers taped active TrPs in the upper trapezius muscle with cross tape, Kinesio® tape, and a sham tape in randomized groupings of participants. The authors concluded that there were no statistically significant outcome measures besides patient perceived pain. This finding could be explained by the space correction method depressurizing the tissues in which the TrPs innervate with, or simply a placebo effect.[29] A separate study by Hashemirad et al. utilized the inhibition Kinesio Taping® method in an attempt to treat active range of motion (ROM) and pain related to TrPs in the piriformis muscle.[23] Through the use of a randomly assigned experimental group and control group study design the researchers found statistically significant improvement in patient perceived pain as well as hip ROM.[23] Lastly, Chao et al. analyzed the effectiveness of Kinesio Taping® combined with manual pressure release (MPR) was compared to MPR alone on treating latent TrPs.[30] The primary outcome measures were subjective pain, pain pressure threshold (PPT), muscle stiffness, and muscle contraction of the upper trapezius muscle. Pain was measured using a visual analogue scale (VAS), PPT with an algometer, muscle stiffness with a myotonometer, and muscle contraction with mechanomyography (MMG). Within both MPR and MPR/MKT groups, PPT improved significantly (d=1.79; $P<0.005$). Additionally, strength of muscle contraction was found to be significantly higher in favor of the MPR/MKT group ($P<0.05$). The same was true for muscle stiffness, measured via myotonometer, which was analyzed using a Mann-Whitney test and yielded statistically significant differences within the MPR/MKT group (0.27 mm to 0.49 mm).[30] Based on these results, the authors concluded that both MPR and the Kinesio Taping® inhibition method are successful in treating symptoms associated with MPS in the upper trapezius. Therapeutic techniques such as dry needling, therapeutic ultrasound, and Kinesio Taping® have also been shown to be quite effective at treating patients who experience myofascial pain.[2,23,26,27,31–35] Contrarily, the infancy of these technologies leads to a wide range of outcomes especially with human studies. This variance of outcomes leads to non-significance of certain findings and makes it difficult for researchers to base their opinions on the overall validity of the treatment.

1.4. Objectives

This review paper is to:

1. Define ITBS and its etiology, diagnosis, and treatment.

2. Define MPS and its pathophysiology, diagnosis, treatment, and outcomes.
3. Determine if Kinesio Taping® is an effective treatment for PPT or fascial correction of ITB trigger points.

1.5. Significance of Review

The significance lies in the necessity for evidence-based practices of Kinesio® tape application. The current literature has many inconsistencies and lacks clear, detailed methodologies for Kinesio Taping® treatments and applications. This review may be used as a reference for clinicians who are exploring treatment methods for MPS and other fascial injuries. The review will attempt to identify and bridge the gap between recommendation and clinical practice. The current literature on Kinesio Taping® for fascial restriction and MPS is limited, therefore making clear recommendations for clinicians challenging. Soft tissue injuries are an overlooked class of orthopedic conditions, and this review primarily focuses on myofascial pain and TrPs.[12,23,26,27,36] These TrPs can be present in active individuals who may not be aware of these effects on their body and physical movements. Fascial restrictions are known to affect not just the site in which pain is felt, so the importance of treating these areas has benefits on the entire kinetic chain surrounding the trigger point.[3,13] The review will provide guidance for evidence-based decision making for treatment of IT band fascial restrictions. Kinesio Taping® methods vary greatly based on the type of tape, desired outcome of treatment, and alterations made to the structure of the tape in order to affect those outcomes. More research is necessary with a universal methodology across all studies to compile a large enough analysis of the clinical effects. Before this occurs, making an evidence based clinical recommendation using Kinesio Taping® techniques for treatment of MPS is unwise.

1.6. **Steps to Conduction of Review**

All research articles were from the PubMed database using keywords; *myofascial pain syndrome, iliotibial band syndrome* and *kinesio tape.* The search results varied based on the keywords used and the type of study design that was filtered in the search. Articles were chosen due to a relevance of using Kinesio Taping® to treat myofascial pain syndrome.

1.7. Definition of Terms

Iliotibial Band (ITB): a thickened piece of fascial tissue on the lateral part of the thigh. The band is a dense, fibrous connective tissue which is not classified as a muscle but instead an extension of three hip muscle tendons.[6,8]

Iliotibial Band Syndrome (ITBS): repetitive friction of the taut iliotibial band (ITB) against the lateral femoral epicondyle during flexion and extension of the knee.[8]

Myofascial pain syndrome (MPS): a disorder associated with multiple trigger points and fascial abnormalities, often presenting as a persistent dull pain. Although the etiology of MPS is insidious, changes in loads on the muscle or increased demands can instigate a sustained muscle contraction.[3,4,28]

Myofascial trigger point (MTP): a focus of hyperirritability in a muscle taut band that is clinically associated with local twitch response and tenderness and/or referred pain upon manual examination.[4]

Kinesio® tape: A therapeutic tape designed to enhance function of tissues and physiologic systems. May be applied for several purposes including muscle facilitation, muscle inhibition, mechanical support, increased proprioception, decreased pain sensation, and increased lymphatic drainage.[14]

Algometer: tool used to measure pain pressure threshold, consisting of a standardized spring with a flattened rubber end and an associated pressure gauge.[37]

2. LITERATURE REVIEW

2.1. Anatomy

An important factor in understanding myofascial pain syndrome (MPS), especially at the iliotibial band (ITB), is to have a detailed understanding of the anatomy of the hip, thigh, and knee. The iliotibial band and the associated muscle groups that articulate through it make up a complex structure; a structure responsible for multiple movements at the hip joint, but additionally provides stability of the hip and knee joints.[1,38] To effectively diagnose and treat ITB pathology such as snapping hip syndrome, iliotibial band syndrome, bursitis, tendinopathies and structural tears, clinicians must be informed of the anatomy.[38] MPS is a complex pathology that can occur anywhere in the body that contains muscle and connective tissues. The muscles and tissues of the thigh and iliotibial tract are a common location for this pathology to occur.

2.1.1. Bones and Connective Tissue

The acetabulofemoral joint, or hip joint, is the skeletal connection between the pelvis and the lower extremity. The joint consists of the head of the femur bone and the acetabulum of the pelvic bone.[39] The acetabulum is made up of three pelvic bones: the pubis medially, the ischium inferiorly, and the ilium superiorly.[39,40] The hip joint is classified as a ball-and-socket joint and the acetabulum forms the socket. Aside from the acetabular notch, it covers the entirety of the femoral head. The transverse acetabular ligament closes the gap of the acetabular notch to form a stable joint connection to the femoral head.[11,39]

The skeletal structures that create the hip joint play an important role in voluntary movement of the lower extremity. Bony protuberances are found in many places surrounding the joint and serve as attachment sites for muscles necessary for movement at the hip. For example, the greater trochanter, a large bony prominence at the proximal end of the femur, is an attachment site for gluteal muscles responsible for abduction of the hip.[6,39] The lesser trochanter, also found at the proximal femur, is the attachment for the iliopsoas muscle, which is the primary mover for hip flexion.[38,39]

Both surfaces of the acetabulum and femoral head are covered with a layer of hyaline cartilage, which cushions the joint through normal articulation during movements of the hip.[39] The acetabular cartilage is thicker and stronger than that of the femoral head due to the added force displacement requirements.[39] Lining the outer rim of the acetabulum and blending with the hyaline cartilage is the labrum. The hip labrum is a fibrocartilaginous structure that serves the primary function of deepening the acetabular cup and help stabilize the joint.[38,39]

The tibiofemoral joint, more commonly referred to as the knee joint, is made up of four main bony structures including the distal portion of the femur, the proximal end of the tibia and fibula, and lastly the patella.[40] The distal femur is separated into two femoral condyles located medially and laterally to the midline of the knee joint. Both have concave facets and are covered with a thin layer of articular cartilage to allow smooth translation of the patella over the surface of the condyles.[41] It is important to note that the knee acts in multiple planes of motion. Not only does the body flex, extend, and rotate at the knee, but the tibia and femur also translates anteriorly and posteriorly when performing any dynamic lower body movement.[40]

The patella, the largest sesamoid bone in the body, is convex on both the anterior and posterior sides, which accommodates the concave femoral surface, forming the patellofemoral joint.[41,42] Similar to the femoral condyles, the underlying surface of the patella is covered with a layer of articular cartilage that dissipates the forces caused by contraction of the quadriceps muscles during knee extension.[41] The patella improves the extension capacity of the quadriceps muscle group by translating the tension force created by muscle contraction over the femur and ultimately pulling the proximal tibia in the direction that produces knee extension.[42] Essentially acting as a lever within the leg, the patella decreases the amount of force required by the quadriceps to extend the leg at the knee.[43]

2.1.2. Soft Tissue Anatomy

2.1.2.1. The Iliotibial Band

The iliotibial band is a dense fibrous band of fascia located in the lateral thigh. The ITB transmits forces created by muscles of the hip and also acts as a lateral stabilizer of the tibiofemoral joint.[38] The ITB originates from the tendinous junction of the gluteus maximus, gluteus minimus, and tensor fasciae latae (TFL) muscles.[5,6,9,38] The fascia latae is a deep fascia of the thigh made up of collagen fibers that stabilizes, encloses, and separates the muscles of the thigh.[6,38] Along the lateral portion of the thigh, the fascia expands from the gluteus maximus posteriorly and the TFL anteriorly.[38] The lateral portion of the fascia latae is the thickest region and binds to the IT band itself.[6,9,38]

2.1.2.2. Muscles of the Hip and Knee

The primary contributor to the mechanism of knee extension is the group of muscles known as the quadriceps. There are four major muscles with six distinct heads that all converge to form the quadriceps tendon and articulate at the patella. The six quadriceps muscle heads include the vastus medialis, vastus medialis oblique, vastus intermedius, rectus femoris, vastus lateralis, and the vastus lateralis oblique.[40] The main function of this group of muscles is to directly facilitate knee extension.

Starting medially, the first muscle that forms the quadriceps group is the vastus medialis, which originates on the medial side of the femur. On the opposite side of the anterior thigh is the vastus lateralis that originates on the greater trochanter of the femur. The vastus medialis and lateralis terminate in an aponeurosis that merges with the anterior joint capsule, and both articulate with the superficial surface of the patella and continues on to the patellar tendon.[40] Located between the proximal muscle bellies of the vastus medialis and lateralis lies the vastus intermedius, which originates on the anterior femur and inserts directly into the quadriceps tendon and ultimately into the superior pole of the patella. Superficial to the vastus intermedius is the rectus femoris, which originates at the anterior inferior iliac spine. The vastus intermedius transitions into the superficial rectus tendon and lies directly superficial to the distal vastus intermedius tendon separated by a significant bursa.[40] These four muscles converge to make up what is referred to as the quadriceps tendon. Four large muscles acting on one area of connective tissue leads to a great amount of force production and workload for the quadriceps and patellar tendons.

2.2. Iliotibial Band Syndrome

Iliotibial Band Syndrome (ITBS) is a chronic overuse condition and common pathology associated with lateral knee pain in activities involving repetitive knee flexion and extension such as running or cycling.[5–11] The syndrome is believed to be caused and exacerbated by excessive friction between the iliotibial tract and the lateral femoral epicondyle.[5–11] The friction between these two structures ultimately leads to inflammation setting in to the posterior fibers of the distal Iliotibial band.[5,7] ITBS literature has reported an incidence rate as high as 52% in high-risk populations.[8] The syndrome is reportedly the most common cause of lateral knee pain and accounts for approximately 12% of all overuse injuries in runners.[7–10] Additionally, ITBS is commonly diagnosed in professional and amateur cyclists accounting for 15% of all overuse injuries in the sport.[10]

2.2.1. Etiology

ITBS typically manifests in affected individuals as pain or tightness of the lateral knee that can extend proximally up the lateral thigh.[5–11] The general cause of the syndrome is biomechanical or anatomical abnormalities and some degree of overtraining.[11] Several causes of ITBS have been proposed including friction of the ITB against the lateral femoral epicondyle, compression of the fat and deep connective tissue, and chronic inflammation of the bursa underneath the ITB and surrounding tissues.[5–11,44] The syndrome can often be caused by a combination of these factors leading to an impingement zone, or an area of anatomical structures at a biomechanical disadvantage.[5–7,9] Located deep and posterior to the distal ITB, the tissues affected by the impingement zone include adipose tissue, fascia, and the posterior fibers of the ITB. During active knee flexion and extension, the posterior fibers of the ITB are affected by compressive and shear forces typically between 20-30 degrees of knee flexion, leading to irritation and inflammation.[7,9]

Differing theories exist in regard to the etiology of ITBS including anterior-posterior friction of the ITB with relation to the lateral femoral condyle, inflammation caused by compression of a layer of fat near distal attachment site of the ITB, and bursitis of the ITB bursa.[5–7,45] The anterior-posterior friction theory recognizes an impingement zone as the ITB translates over the lateral femoral condyle when the knee is flexed to 30 degrees.[5–11,44,45] This precise knee angle occurs at heel strike during a normal running gait.[7,45] The next theory relates pain to the compression of an adipose layer that lies deep to the distal attachment of the ITB. This compression is caused by various tensile forces acting on the ITB fibers during knee flexion.[6,45] Finally, the bursitis theory identifies a possibility for an inflammatory response of the bursa separating the ITB and the lateral joint capsule of the knee.[45]

For decades ITBS was believed to be initiated by friction caused from an anterior-posterior glide of the distal ITB. However, a group of researchers have suggested ITBS is in fact not triggered by friction.[5,6] Instead, the researchers suggest that ITBS is caused by varying tautness of the anterior and posterior fibers of the distal ITB during the flexion/extension mechanism, which causes an increased compression of the innervated layer of fat and connective tissue that separates the ITB from the lateral femoral epicondyle.[5,6] This theory is supported through anatomical study of the ITB, the tensor fascia latae (TFL), and the lateral supracondylar region of the femur.[5,6] The ITB is influenced by the TFL, which is tethered throughout its length to the linea aspera, or the ridge along the posterior surface of the femur.[5,11] This strong anchoring of the fascia latae to the skeleton would restrict any shearing movement of the ITB because the fibers are progressively tensioned during knee flexion.[5,6] It's believed that because of the fibrous connections, anterior-posterior movement of the ITB is limited.[5] Fairclough et al. does state, however, that there is potential for slight medial-lateral migration of the ITB, which they believe can contribute to the compression of the tissue deep to the ITB.[5] This compressive force increases pressure on the impingement zone, which contains the richly-vascularized femoral epicondyle and loose connective tissue that is known to contain pressure-sensitive nerve endings called Pacinian corpuscles.[5] Despite a clear mechanism for the cause of ITBS, the etiology of the syndrome is inarguably rooted in repetitive knee flexion and extension.

2.2.2. Diagnosis and Treatment

ITBS is often presented as insidious sharp lateral knee pain, which is painful with palpation of the lateral femoral epicondyle.[5–8,10] The mechanism of ITBS is described repetitive knee flexion/extension, so naturally the syndrome has a high prevalence rate in runners, cyclists, and a number of field athletes.[5,7–11] Patient history is often consistent with a sudden increase in long duration aerobic activities.[46] In most cases pain initially occurs at the completion of prolonged activity and is often absent throughout shorter distance runs.[7,46] In later disease progression and in more severe cases of ITBS pain may be reported during the beginning of activity, with activities of daily living (ADLs), or even at rest.[7,46]

During orthopedic evaluation of the knee, ITBS presents with painful palpation of the distal fibers of the ITB with or without crepitus during range of motion.[5,7–11,46] The only other significant findings that may present during physical examination are knee misalignments such as genu varum, genu valgum, or recurvatum found during postural assessment that may contribute to increased tension of the ITB.[46] Two commonly utilized orthopedic tests for ITBS include Ober's test for ITB restriction and Noble's compression test for ITBS.[7,10,11,46] To perform Noble's test the clinician first palpates the distal ITB at the lateral femoral epicondyle with the patient in a side-lying position with the involved knee flexed to 90 degrees. Next, the clinician passively extends the patent's knee from 90 degrees of flexion to 0 degree of extension while maintaining palpable pressure of the distal ITB. A positive Noble test is defined as reproducible pain at approximately 30 degrees of flexion.[7,11,46] The purpose of this test is to identify reproducible symptoms caused by ITBS.

Ober's test is similar to Noble's compression in that it can be used to identify factors contributing to ITBS, but instead examines tightness of the entire ITB rather than just the distal fibers.[10,47] This orthopedic test is performed beginning with the patient in the same side-lying position with the involved knee at 90 degrees of flexion.[10,46,47] The clinician then stands behind the patient and uses one hand to stabilize at the pelvis while using the other to abduct and extend the hip of the affected side. While maintaining stabilization of the pelvis, the clinician lowers the limb into adduction until it stops due to soft tissue restriction or the patient's pelvis begins to move to compensate further movement. The degrees of hip adduction, or abduction if the patient is unable to adduct past neutral, is then measured with a goniometer.[10,47] If goniometry reveals any degrees of abduction, the test would be considered positive for ITB tightness and any degrees of adduction is considered a negative test.[47] Ober's test has an inter-rater reliability 0.59-0.97 and an intra-rater reliability of 0.90- 0.91.[47,48] Contrary to Noble's compression test, Ober's does not attempt to reproduce symptoms of ITBS, but is used to identify if soft tissue restrictions of the ITB are present.

The vast majority of ITBS cases are treated conservatively, but in certain progressive cases or under rare circumstances may be treated with surgical intervention.[7,8,10] Like many orthopedic inflammatory conditions, ITBS begins with the acute inflammatory phase. During this period, treatment is focused primarily on managing patient's pain and reducing inflammation. Analgesics such as ice and non-steroidal anti-inflammatory drugs (NSAIDs) are often used at this time to achieve treatment objectives.[7,10] While ice and NSAIDs can help shorten the inflammatory phase, the best way to ensure a reduction in ITBS symptoms is by altering the training volume that the patient is involved in. Once out of the subacute phase and the patient's pain is tolerable, treatment focus shifts to tissue mobilization through stretching, manual therapy, and therapeutic exercise.[7,10] Despite ITB length and relative tightness not being a direct indicator of ITBS, it is recommended to stretch the ITB and other structures of the hips and lower extremity that are indicated as having restricted flexibility.[10,36] To effectively stretch or lengthen the ITB, the patient is placed in an upright standing position, then in order to adduct at the hip, the patient is instructed to place the foot of the affected side behind wrapped around to the lateral side of the contralateral foot.[10,36] To intensify the stretch, the patient is instructed to raise their arms overhead and laterally bend the torso towards the unaffected limb, which placing the ITB in a maximally lengthened position.[10,36]

After the acute and sub-acute inflammatory phase is complete, new connective tissue is orienting to the existing tract fibers, therefore the tissues can be misaligned which must be addressed to properly treat ITBS.[7,10] Forms of myofascial release have been backed by research and found to be affective, however, the evidence remains limited.[8–10] The final phase of ITBS treatment is addressing areas of strength imbalances with regard to hip musculature. Associated weakness or imbalances of the hip musculature can lead to improper gait or compensation.[7,10]

In more progressive cases of ITBS where symptoms are not managed with conservative treatment, surgical intervention may be recommended by an orthopedic specialist.[7,8,10,45] Surgical procedures differ case by case, however most involve the removal of irritated structures or even frayed or damaged fibers of the ITB itself.[7,8,10] Overall, ITBS treatment requires a detailed approach with consideration of the phases of tissue healing, and potential soft tissue restrictions.

2.3. Myofascial Pain Syndrome

One of the primary factors contributing to muscular pain, myofascial trigger points, are defined as noninflammatory, hyperirritable nodules formed within the fibers of the muscle and the surrounding fascia.[12] Fascia, both superficial and deep, is a composition of fat and connective tissues and lie between the dermis and muscle tissue.[26] Myofascial pain syndrome (MPS) is a disorder associated with one or more palpable trigger points and fascial abnormalities. Myofascial pain manifests in a variety of intensities and point of onset and often presents as a persistent dull pain. The etiology of MPS is insidious; however, an increase in muscular demands from physical loads can instigate a sustained muscle contraction.[28] Patients who suffer from myofascial pain often use protective and compensatory movement patterns to reduce painful stimulus, such as altered gait pattern.[23] Overall, myofascial pain is a disorder with an insidious onset and associated TrPs, which are treatable with therapeutic intervention and adjustments to physical demands.

2.3.1. Pathophysiology

Two theories have been formed by researchers to explain the phenomenon of myofascial trigger point formation.[12] The strenuous demand of the active TrP, even at rest, causes an increase in energy consumption secondary to the release of the neurotransmitter acetylcholine (ACh). Acetylcholine is a chemical message released by neurons to send messages to other cells.[49] Due to the excess of this activating chemical at the motor endplate of the muscle fiber, a prolonged depolarization phase occurs. The purpose of the depolarization phase is to open cell membranes, thereby allowing the flow of negative calcium ions to spur the contraction of muscle fibers.[12] However, in this state of disrupted homeostasis, cells cannot regulate correct exchange of nutrients, leading to a detrimental amount of free calcium ions.

The first theory discussed in literature is the energy crisis theory, which suggests an influx in calcium on repeated microtrauma and neural demands placed on the muscle tissue.[28] The calcium ions cause a sustained muscle contraction, thereby resulting in a higher demand for energy, spurring the injurious cycle to repeat. The muscle contracture secondary to incessant flow of ACh, combined with the provoked sensory receptors responsive to pain, explains the physical symptoms and pain associated with TrPs.[12] Consistent shortening at the motor end plate also depletes circulating oxygen, leaving the cells incapacitated and unable to produce energy at the rate the tissue needs to cease the contraction.[28] The lack of circulating blood through the vessels causes the fascia to become inflexible and a hindrance to movement.[26] Additionally, when tissue metabolism is forced to occur in an ischemic state, nociceptors become more sensitized, eliciting a pain response.[28]

The second theory, motor end plate theory, works in conjunction with the energy crisis theory. In this theory, the motor end plate, a synapse between the motor neuron and myocyte, is responsible for small amounts of muscle contracture. Intramuscular electromyography studies found the loci coinciding with motor end plates produce diminutive electrical activity, which represents the release of ACh.[28] As discussed previously, excess ACh exacerbates the issue by inciting more muscle shortening. By incorporating both motor end plate and energy crisis theories, researchers conjecture about the origin of myofascial trigger points; however, the exact derivation remains unknown.[12]

Myofascial TrPs can be classified into four categories depending on the mechanism or symptoms. The first, primary TrPs are produced by either an acute mechanism or repeated stress to the tissue. The symptoms associated with primary TrPs are unrelated to any other muscle. On the other hand, secondary TrPs are the consequence of mechanical damage produced by a primary TrP.[12] Myofascial trigger points can be further grouped by symptoms as latent or active.[12] Active and latent TrPs differ in distinct mechanisms. Latent TrPs have less clinical significance than those of active TrPs; however, a latent trigger point has the ability to worsen and develop into an active TrP.[12] Pain associated with latent TrPs is only induced upon palpation of the taut band and does not produce any symptoms without provocation.[12,28] Furthermore, the pain initiated by a latent TrP may not be familiar to the patient. In order for a TrP to be classified as active, the pain must be recognizable upon palpation.[28] A non-specific or unfamiliar pain produced upon palpation of the taut band is considered inconsequential to some clinicians.[28] Latent TrPs, considered by those standards, are insignificant and noncontributory to myofascial pain.[28] Regardless of being classified as latent, TrPs have the potential to worsen and become increasingly symptomatic, thus changing to the active classification.

Referred pain can be present in both latent and active TrPs and is a common chief complaint of MPS patients.[12] Common with active TrPs, referred pain is the only nociceptive sensation apparent and is often unrelenting.[12] Described as a 'misinterpretation of stimulus,' researchers have speculated about referred muscle pain for years. The convergence projection theory, a traditional explanation for referred pain, is centered around noxious stimulus to the posterior gray matter of the spinal cord, or the dorsal horn neurons.[28] Researchers theorize dorsal horn neurons become more sensitive to stimulus consequential to the incursion of chemical transmitters derived from pain. This explains the idea of referred pain because the dorsal horn neurons have links to more than one part of the body; therefore, when stimulus derives from multiple body regions, the dorsal horns are unable to differentiate where the pain originates.[28] Other researchers speculate there is an inactive version of convergent connections, which is initiated by the first stimulus of pain.[4,49] In this slightly varied theory, dorsal horn neurons receive noxious information from only one area. Once a stimulus is received, previously dormant receptors begin transmitting. Referred pain occurs because the dorsal horn neurons detect the signals as originating from multiple areas.[4,28,49] The presence of referred pain as a symptom is a distinguishable factor between myofascial pain syndrome and other musculoskeletal pathologies such as fibromyalgia.[1] While referred pain has a systematic pattern, it does not correspond with the pattern of dermatomes. Although the mechanisms of referred pain are not absolute, it is an undeniable symptom of MPS and a clinically significant patient complaint.

A secondary characteristic attributed to both active and latent trigger points is a local twitch response (LTR).[1] A local twitch response is a small but rapid contraction of the involved muscle upon palpation of the taut band. Also termed the "sensitive locus," the LTR is one of many loci mapped by clinicians using TrP injections. With elevated electrical activity compared to neighboring tissue, the "active locus" typically correlates with the motor end plate. Based on the observation of spontaneous electrical activity during TrP injection, the proposed hypothesis is that a TrP develops when a sensitive locus (local twitch response), active locus (motor end plate), and pain receptor (nociceptor), all overlap.[4,13] Researchers also speculate there is a scattered population of sensitive loci throughout a single muscle, increasing in concentration near TrPs, thus adding yet another level of complexity to the theory of referred pain.[3,4] Overall, the local twitch response is commonly discussed in the literature as a characteristic of all TrPs.

2.3.2. Diagnosis and Treatment

Myofascial pain syndrome is prevalent, not only in the competitive athletic population, but recreational athletes as well. Up to 54% of women and 45% of men experience myofascial pain in some regard.[12] In an athletic population, trigger points are common secondary to a dissimilar injury or a soft tissue pathology such as muscle imbalance or poor posture.[28] In the general population, TrPs are common but may present with differing symptoms due to the mechanism. The demographic frequently affected is sedentary people ranging from 27.5-50.0 years old.[2] For example, office workers who sit for long periods of time with incorrect posture and sustained muscle contracture may develop cervical or thoracic TrPs, which present as a headache or neck pain.[28] Specifically, there are characteristics identified by researchers as criteria for diagnosis of MPS and the associated active and latent TrPs (Figure 1).[3] A more general diagnostic criterion includes a local twitch response, familiar pain on reproduction of symptoms, and a taut band associated with pain on palpation.[28] Overall, MPS is a common disorder affecting a diverse population and can be debilitating if the contributing factors go untreated.

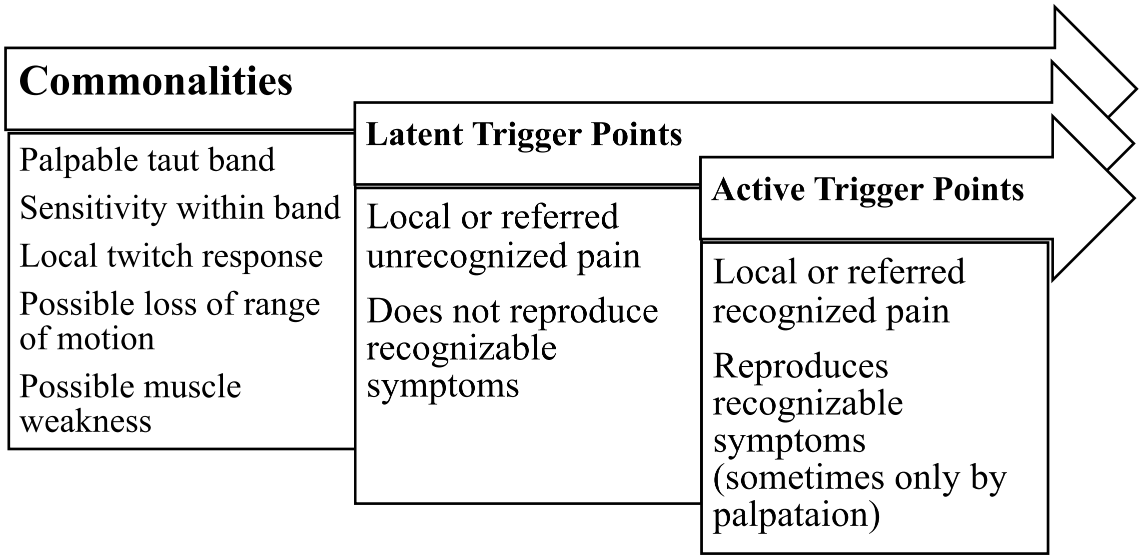

Figure 1. Diagnostic Characteristics of Myofascial Pain Syndrome[13]

Myofascial trigger points can be diagnosed in a variety of ways, but commonly through a detailed history of symptoms and reliable physical evaluation.[1] However, there are several factors that affect the reliability of diagnosing TrPs via clinician palpation.[28] Patient position, force applied to the tissue, and most significantly, palpation technique, influence the reliability of locating TrPs.[28] There are three main types of palpation methods clinicians utilize for TrPs: direct finger pressure, flat palpation, and pincer palpation.[12] Pincer palpation is the best maneuver for deep TrPs while the other two methods are valid for superficial tissue. Based on research, the most appropriate technique clinicians should consider when attempting to reproduce symptoms of a TrP is a pressure of approximately two kilograms per centimeter squared (kg/cm^2) applied over two to five seconds. Researchers compared inter-rater reliability of TrP diagnosis between experts and trained and untrained clinicians.[27] Out of three TrP characteristics, referred pain was the only significant reliable diagnostic variable for expert clinicians compared to trained (kappa=.342) and untrained clinicians (kappa=.326). Overall, concurrence for referred pain among the trained examiners (kappa=.435) and untrained examiners (kappa=.320) was more significant than for presence of taut band (kappa= 1.08, -.019) or local twitch response (kappa=-.001, .022).[27] The presence of a local twitch response or palpable taut band was found to be unreliable indicators between examiners. Considering inter-rater reliability, the most dependable indication of TrP diagnosis is the reproduction of local or referred pain via direct pressure.[27]

Additional diagnostic tests can be used for myofascial trigger points. Electromyography (EMG), algometry, and diagnostic ultrasound are frequently referred to in the current literature.[12] Electromyography can be used in a variety of circumstances.[1] Intramuscular EMG is most effective and penetrates the muscle fibers, eliciting a heightened response when the clinician finds an active locus of TrP.[1] Furthermore, algometry measures pain pressure threshold (kg/cm^2) via hand-held device and helps the clinician understand the location and severity of the TrP.[1] Algometry is a convenient way to quantify the progress of TrPs but can also be used to locate TrPs through the presence of a low pain pressure threshold score, which is measured in kg/cm^2.[50] Both accurate and accessible, ultrasound imaging techniques are useful, non-invasive complementary tools for pinpointing TrPs and will be discussed in further detail in a later section.[35] Although there are several tests to diagnose TrPs discussed in the literature, one does not noticeably surpass the others in reliability.

Myofascial trigger points can be treated through both invasive and non-invasive procedures. Injections are one example of an invasive treatment. Injections can be either non-medicated, such as dry-needling, or medicated with prescriptions such as botulinum toxin (BT). Notably, there is an obvious risk of infection associated with invasive procedures, which does not exist with non-invasive treatments.[1] Botulinum toxin is an analgesic used under the assumption TrPs produce excess ACh because the base ingredient for the toxin blocks ACh before it enters the muscle.[28,51] As a result of inhibiting ACh, BT has the effect of sustained muscle relaxation.[51]

A recent study performed on a larger sample (N=132) examined the effect of BT on myofascial pain syndrome.[51] Participants suffering from chronic neck pain were grouped randomly to receive either saline injection (n=35) or BT doses of 10 units (n=32), 25 units (n=34), or 50 units (n=31); the mean ages for each group were 45.3±10.1, 43.3±10.9, 46.6±15.1, and 46.5±12.2, respectively.[51] Subjects were assessed for pain via visual analogue scale (VAS) and pain pressure threshold via algometer at pre-injection, post-injection, and then every other week for 12 weeks starting one week post-injection. Researchers found no significant differences for VAS (P=.87) or pain pressure threshold (P=.61) with repeated measures ANOVA comparing each BT dosage group to the placebo group.[51] It should be noted that a delimitation of the study includes the use of several additional treatments for MPS, which all groups received throughout the 12-week study. Regardless, researchers conclude BT injections of TrPs are not a recommended treatment for MPS in the neck because the addition of the medication was not superior to saline.[51]

Dry needling is a technique that has been researched in relation to treatment of MPS. The theory of the dry needling technique is to elicit the local twitch response of the TrP in order to lower muscle tension and pain through the insertion of small needles into specific muscles.[1,28] There are various methods of dry needling that have been developed to treat TrPs associated with MPS; for the purpose of this review, only a small portion of the literature will be discussed. Recruiting from an outpatient clinic, subjects who suffered from symptomatic TrPs for at least six months were obtained for a four week, double-blinded, randomized study.[32] The subjects were randomized into either a dry needling treatment group (n=22; 42.9 ± 10.9 years) or a sham needling group (n=17; 42 ± 12.0 years). The patients were assessed for perceived pain using VAS scores, as well as quality of life via a questionnaire called Short Form-36.[32] Patient outcomes from the questionnaire were only obtained pre-treatment and post-sixth treatment. The details of the tool were not reported by the researchers; therefore, the results will not be analyzed in this review. Furthermore, in this mixed methods study, patient outcomes of pain severity were measured with VAS.[32] Dry needling treatments were performed by a physician and took place over six sessions: twice a week for two weeks, then once a week for two weeks. In a repeated analysis, researchers found significant lower VAS scores within the dry needling treatment group following session one (P=.000) and six of dry needling (P<.000). Additionally, VAS scores post-initial treatment (P=.034) and post-sixth treatment (P<.001) were significantly lower in favor of the dry needling treatment group.[32] For this reason, the researchers conclude dry needling treatments are effective in reducing perceived pain associated with MPS, with respect to this specific method of application.

Exploring comparable patient outcomes, researchers studied the novelty of dry needling to conservative physical therapy techniques for the purpose of comparing pain pressure threshold and VAS scores in patients with myofascial pain of the upper trapezius muscle.[33] Thirty-seven patients were recruited using convenience sampling and analyzed according to predetermined inclusion criteria, which consisted of the presence of active trigger points in the upper trapezius muscle for greater than two months.[33] The final randomized groups, who met the criteria and completed all follow-up appointments, consisted of 14 subjects receiving an invasive dry needling treatment, and 14 subjects completing a non-invasive physical therapy (PT) program. The pre-treatment characteristics for the treatment groups are listed in Table 1.[33] The physical therapy program consisted of 10 sessions, three times a week, during which the physical therapist applied stretching combined with various therapeutic modalities: superficial heat, transcutaneous electrical stimulation, and thermal ultrasound. In contrast, the dry needling group received one treatment to the two most symptomatic TrPs of the upper trapezius. Outcome measurements consisted of VAS scores, pain pressure threshold, and a quality of life questionnaire. Each outcome measurement was obtained one week and one month following the final treatment for both groups.[33] The same quality of life questionnaire, Short-Form-36, was utilized as Tekin et al.[52] However, in this study, researchers reported the outcomes obtained were categorized into eight scales, scored quantitatively from 0-100.[33]

Table 1. Pre-treatment Group Characteristics[33]

	Dry Needling group (n=14)	Physical Therapy group (n=14)
Age (years)	32.0 ± 10.0	38.6 ± 4.2
Symptom Duration (months)	9.6 ± 8.4	9.8 ± 9.6

Paired *t*-tests were performed on data collected at one-week follow-up and indicated significant increases in pain pressure threshold for both the dry-needing and PT group ($P<.05$).[33] The physical therapy group, however, was alone in improving quality of life, with significant increases in three of the eight categories as shown in Table 2. However, since the physical therapy group received multiple therapeutic modality treatments throughout a 10-session program, the results of this analysis lose clinical significance because it is not determinable which aspect of the physical therapy session affected the patient's perceived outcomes. Nevertheless, at the one-month post-treatment, the dry needling group became equally effective in improving the measured outcomes compared to the physical therapy group.[33] Both groups had significant increases in pain pressure threshold and four out of the eight quality of life Short Form-26 categories ($P< .05$). Also, in the 1-month follow-up session, researchers conducted an ANOVA between both groups and found no significant differences in any measured outcome ($P>.1$).[33] Overall, the clinical implication of this study is limited by the multiple interventions within the physical therapy group. Nevertheless, the authors conclude a matched level of effectiveness between dry needling and physical therapy in treating patient outcomes and pain pressure threshold associated with myofascial pain syndrome.

Table 2. Quality of Life Scores: Physical Therapy Group: Pre-treatment and 1-week Follow-up[33]

	Physical functioning	Role limitation due to physical problems	Social Functioning
Pre-treatment	72.5 ± 19.8	41.3 ± 44.3	71.4 ± 17.9
1-week follow-up	80.0 ± 15.9	53.5 ± 40.3	67.8 ± 18.2

Therapeutic ultrasound is another commonly mentioned thermal intervention for TrPs, but the wide range of methodology with lack of universal procedures weakens the significance of the current evidence.[34] The therapeutic aspects of ultrasound can be either thermal or non-thermal effects caused by vibrations of sound waves.[34] Reportedly, thermal effects on soft tissue include increased blood flow and collagen elasticity in tendons, ligaments, and joint capsules, subsequently reducing stiffness.[34] Possible non-thermal properties of the ultrasound waves are analgesic in nature and incorporate decreased painful stimulus received by the central nervous system with general desensitization of the nervous system to reduce the patients' perceived pain.[34] Due to inadequate controlled methodological studies regarding the efficacy of therapeutic ultrasound in treating MPS, Kavadar et al. performed a study analyzing pain, PPT, and psychological implications following conventional ultrasound.[34] Fifty-nine (N=59; m=10, f=49) patients with upper trapezius myofascial pain received either an ultrasound treatment (n=30; 37.4 ± 9.1 years) or a sham ultrasound (n=29; 35.8 ± 5.7 years) for six-minute sessions, 15 times. Outcome measures were acquired pre-, immediately post- and three-month post- treatment.[34] The researchers' report stated an equivalent significant difference (P<.01) for the treatment and control groups in all outcome measures when comparing pre- treatment outcomes to immediately post- and three-month post. The groups differ upon between-group analysis; the placebo group fell short of the treatment group in all patient outcomes immediately post- and three-months post- ultrasound treatment (*P*<.0001).[34] Regardless of the significant difference between the groups in favor of the ultrasound group, the significance within the groups' pre-post analyses lessens the implication of ultrasound as a treatment for TrPs considerably.[34]

Despite the extensive collection of research on therapeutic ultrasound, a gold standard protocol does not exist for the treatment of myofascial pain syndrome. For this reason, Ilter et al. equated separate settings of ultrasound in attempt to establish a set of best practice parameters.[31] Comparing pulsed (also referred to as interrupted) to continuous ultrasound, the researchers examined several patient outcomes related to MPS: pain, function, severity of muscle spasm, and several aspects of mental health and quality of life.[31] As a result of convenience sampling at a physical rehabilitation clinic, 77 subjects met the diagnostic criteria for trigger points detailed by Travell and Simons.[13] Due to attrition, the randomized groups (N=60) were subcategorized as the following: continuous ultrasound (n=20; 33.0 ± 8.0 years), pulsed ultrasound (n=20; 32.0 ± 7.0 years), and sham ultrasound (n=20; 33.0 ± 8.0 years).[31] The participants were further characterized by occupation, duration of pain, sex, and education; however, there was no statistically significant difference between these nominal scales (*P*>.05). All three intervention groups were given the pre-assigned five-minute treatment five days per week for two weeks. Further therapy prescribed to all subjects included standard stretching and range of motion exercises as well as superficial heat, which was documented with journal entries.[31] Notably, the patients were allowed over the counter acetaminophen pain relief medication when needed. The use of medication is a considerable limitation of the study because the dosage and time of intake was not controlled and could have affected the patient perceived outcomes.[31]

Researchers measured pain as the primary outcome via an 11-point VAS assessing the patient's pain in the most recent 48 hours. Secondary outcomes included an ordinal scale severity for muscle spasm, and interval scales for psychological state, quality of life, function, and patient satisfaction.[31] All outcomes were obtained pre- and post- treatment, as well as at a six- and 12-week follow-up. For VAS pain scores, a Wilcoxon paired *t*-test revealed significant improvements in the continuous (P=.003), pulsed (P=.001), and sham (P=.001). The researchers found a similar trend for both severity of muscle spasm (P<.001) and disability scores (P=.007, P=.001, P<.001, respectively).[31] Identical to the previous study, this indicates all subjects, no matter the group, perceived improvement in pain, muscle spasm, and function.[31,34] Again, it could be assumed that this is due partly to the placebo effect of a single-blinded study. Furthermore, a Kruskal-Wallis ANOVA analysis was completed to compare changes between the groups following the ultrasound treatment. Researchers reported significant improvement in pain (VAS) scores at the 6-week (P=.035) and 12-week follow-up (P=.013) for the group treated with continuous ultrasound.[31] Conclusions based on the results indicate continuous ultrasound may be indicated over other parameters when treating pain associated with MPS.[31] Although research analyzing the effectiveness of therapeutic ultrasound for MPS exists, it remains inconsistent procedurally and inconclusive.

Due to the various treatment options for symptoms associated with MPS and TrPs, careful consideration and evidence-based clinical application should be used regardless of the treatment applied. There is contradictory research validating the use of one treatment as the 'gold standard' for myofascial pain syndrome. Whether invasive or non-invasive, the clinician applying the specified treatment should have background knowledge of the treatment as well as the patient's symptoms. Lastly, because myofascial pain syndrome is multifaceted and can manifest several symptoms, clinicians should take care to understand the nature or cause of the symptoms when choosing a treatment option.

2.4. Kinesio® Tape

Kinesio® Tape was developed in the late 1970s by Dr. Kenzo Kase, a Japanese chiropractor, to influence the sensory motor loop between the superficial nerves of the dermis and the brain.[53] The Kinesio Taping® treatment has since been theorized to have many orthopedic applications. Initial claims made by Dr. Kase suggest that Kinesio® Tape had physiological effects including a decrease in pain by stimulating the neurological system, restore correct muscle function by supporting weakened muscles, remove congestion of the lymphatic fluid or hemorrhages under the skin, and correct misalignment of joints by reducing muscle spasms.[53] There is minimal evidence supporting the use of Kinesio® Tape in some of these claims. However, there has been evidence supporting an increase in the space between the skin's underlying fascia and the muscle tissue beneath with Kinesio® Tape treatment.[54] This lifting of the skin helps promote blood flow and lymphatic drainage. The claims that it facilitates and corrects muscle function have been studied and have shown conflicting data.[53]

Kinesio® Tape is a common therapeutic approach due to anecdotal evidence of improvement in patient perceived outcomes in conjunction with its non-invasive design.[15,25] Along with pain relief, kinesiology tape also improves range of motion (ROM), strength, balance, and neuromuscular function.[55] Researchers measured the significant and insignificant results of the aforementioned findings in a review of current clinical studies (Table 3).[55] It is difficult to identify a single outcome as being superior based on these findings, although the overall percentage of favorable results does indicate some success with strength and proprioception. Only ten papers fit the researchers' criteria, which constrained the amount of data available for analysis even though they did not conclude that kinesiology tape is an effective treatment for pain. The relevance of the effectiveness of the outcome measures is diminished by the dearth of research on kinesiology tape.[55] Furthermore, a brand definition is not part of the researchers' inclusion or exclusion criteria. Therefore, it cannot be assumed that Kinesio® Tape was used in all included clinical trials.[55] Although the present body of research on Kinesio® Tape is insufficient, its effects can be beneficial in a number of ways, making it a well-liked, non-invasive treatment choice for musculoskeletal diseases.[15,56,57]

Table 3. Number of Significant and Insignificant Results, and Percentage of Overall Positive Results, for Pain, Range of Motion (ROM), Strength, Proprioception, and Muscle Activity.[55]

Outcome measure	Significant positive results (N)	Nonsignificant results (N)	Overall positive results (%)
Pain	2	6	25
ROM	16	56	22
Strength	6	10	38
Proprioception	2	2	50
Muscle Activity	4	18	18

2.4.1. Tape Characteristics

Kinesio® Tape was invented and designed for the purpose of being a strong, yet flexible and functional product that can be applied and worn comfortably for extended periods of time. To achieve this, the construction of the tape itself includes a mixture of polyurethane synthetic fibers, cotton fibers, and an acrylic adhesive.[57] The adhesive used for most brands and styles of kinesiology tapes is often hypoallergenic and thermoactivated because of its design to be worn for multiple days before removal. This is important because throughout the literature, data collected one to two days after application of the tape demonstrates a statistically significant effect when compared to data collected directly following application.[20] Kinesio® Tape differs from other athletic tapes because of its unique elastic properties. This tape is capable of stretching up to 130-

140% of its resting static length and is also quick drying and designed to mimic the qualities of human skin.[53]

TEMTEX® kinesiology tape underwent a complex analysis of the material composition and geometry at the micro level of the fibers, yarns, and woven fabric of the tape.[56] The tape was carefully deconstructed and evaluated using longitudinal and cross sectional microscopy analysis.[56] The kinesiology tape was analyzed for fiber and adhesive composition, porosity, air and water vapor permeability, and mechanical and thermophysical properties. The tape is found to be made up of two types of yarns. Warp yarns that run vertically with the tape design are constructed with an elastane filament with traditional cotton fibers acting as a shell. Weft yarns, or the horizontal structure of the tape design are 100% cotton spun yarns. This unique design allows for the tape to stretch up to 160% longitudinally without changing its horizontal width. Once woven, an adhesive is applied to one side of the tape. This adhesive is heat activated, 100% acrylic, and is applied to the tape in a "wave like" pattern to mimic a fingerprint found on a human fingertip.[56] With the tape in a relaxed state, the adhesive only covers about 76% of the surface area of the applied side. This design allows for increased areas of air and water permeability while maintaining strong contact to the skin. As the kinesiology tape is stretched, the areas of no adhesive, otherwise referred to as pores, increase in number and in size. The increase in non-adhesive surface area directly increases the breathability of the tape through increased air and water vapor permeability. The tensile strength of TEMTEX tape ranges from 80 to 180 N depending on the width of the tape, with wider tape having the greater resistance to tensile load. Kinesio® brand tape is comparable in design and in functionality; however, it can not be said with certainty that the data from this study directly correlates to other kinesiology tape brands.[56] More research is needed specifically on Kinesio® tape composition and functional testing to make such claims.

Elastic tape for sport and clinical use has unique mechanical properties as discussed briefly in the previous study.[56] The goal of tape application is to use these properties in a way that creates a physical change on the area being taped. A cross-sectional laboratory study compared the mechanical properties of five different tape products including: Kinesio Tex Gold®, Kinesio Tex Gold - FP®, Kinesio Sport®, Rock Tape® and Premium Kinesiology 3 NS Tex®.[57] Data were recorded on maximum deformation, maximum load, maximum tension, and relative stiffness. Each tape product underwent a longitudinal traction test until the tape sample ruptured. Computer software TESC 3.04® was used to analyze load vs. deformation in real time. Kinesio Tex Gold - FP® performed the best during testing, yielding a maximum tension of (301.42Pa) which was 19.9% more than the worst performing tape product, Rock Tape®. Kinesio Tex Gold - FP® also had the highest maximum load of (215.87N) and was 21.9% higher than the lowest performing product, Rock Tape®. Kinesio Tex Gold - FP® also measured the highest relative stiffness at (5.14 N/mm), over 24% higher than Kinesio Tex Gold®. Interestingly, Kinesio Tex Gold® had the highest maximum deformation at (244.83%), while Rock Tape® had only (187.44%) deformation.[57] Despite similar design and construction, findings suggest significant differences in the mechanical properties of each of these tape products. This study highlights the importance of careful consideration when selecting a tape product for treatment of a specific condition.

Similar to the previous study, 19 different kinesiology tape brands were evaluated for mechanical properties, adherence, and removal from skin in dry, wet, and submerged state.[58] Each brand of tape underwent multiple forms of testing including: pre-elongation capacity, maximum force, tenacity, work, elongation once paper was removed, and adherence force. Results of the study parallel those of the previous. Statistically significant differences were found between kinesiology tape brands in every single property that was tested for. The objective of the study was to define the characteristics, mechanical rupture point, and the adhesive properties of a variety of kinesiology tapes.[58] In the process of defining these characteristics, the authors of the study highlighted the need to define a standard application criterion that future studies can utilize to be able to accurately reproduce and continue the research.

There seems to be several design flaws found throughout the kinesiology tape literature that negatively affects the validity of the results of individual studies. First, the lack of a general consensus of an agreed upon methodology of the application of kinesiology tape is an important factor to consider when reading kinesiology tape research.[58] Being able to replicate a study is critical to allow for further research and confirmation of the previous findings. Positive results from past kinesiology tape studies may be attributed to placebo effects as a result of not having the option of using an agreed methodology.[58] Another overlooked factor in kinesiology tape research is the varying brands of tape that are used in these studies and the lack of understanding of the differing composition and properties of each type of kinesiology tape product available. Different manufacturers have added new materials to their products to change the original design of Kinesio® Tape. They aim to enhance the quality of the adhesive as well as the strength and tension capability of the tape. By changing the composition of the tape, however, they are indirectly altering the way that the tape will interact with the skin and underlying tissue.[57] There appears to be at least some merit for using Kinesio® Tape as a treatment. Keep in mind that there should be continued examination of the current literature in order to clarify if the Kinesio® Tape has statistically significant clinical benefits.[53]

2.4.2. Kinesio Tex Tape®

Kinesio Tex Tape® (KTT) claims to aid the muscle and lymphatic systems by providing a mechanical support while allowing for unrestricted motion.[15] Traditional taping techniques use either rigid non-elastic or semi-elastic tape products that limit natural body movement while providing structural support. Proper tape application according to KTT tape manufacturers will create micro convolutions, or folds, in the skin that is in contact with the tape. The folds cause a lifting of the skin and a separation from the tissue layers beneath it.[15,54] The release in pressure and increase in space between tissues facilitates increased lymphatic fluid movement. Claims of pain relief, improved lymphatic drainage, improved joint position, proprioceptive feedback, and prevention of over-contraction have been studied.[15,20,22,53,54,59]

In a systematic review of KTT clinical effects, in which all studies that included any other brand or style of tape were excluded, 27 trials were obtained and synthesized to investigate the effect of KTT in the management of any condition.[15] Ultimately only eight randomized controlled trials met the inclusion/exclusion criteria for the review. Six studies included patients with musculoskeletal conditions, one studied cancer-related lymphedema, and one studied stroke patients with associated muscle spasticity. Of the eight studies included in the review, statistical significance was found in favor of KTT tape over other clinically accepted treatment or sham conditions in only two. In a randomized controlled trial studying the use of KTT for treatment of plantar fasciitis, there was limited evidence that supported statistically greater improvement in pain and fascial thickness. This improvement was found in patients who were treated with KTT in conjunction with physiotherapy versus physiotherapy alone after one week post-treatment.[15] The second study included in the review that yielded positive results in favor of KTT was in a study of function, pain, range of motion, and muscle endurance in patients with chronic low back pain.

Subjects that received KTT treatment demonstrated statistically significant improvements in muscle endurance and in pain symptoms.[15,25]

2.4.3. Methods of Tape Application

Dr. Kenzo Kase is credited with the design of Kinesio® tape, additionally he is also credited with creating the methods of application for the various therapeutic interventions indicated for kinesiology taping.[14] The application techniques are used with the goal of achieving desirable outcomes. The space correction method is a frequently used technique that appears in the literature.[26] According to the space correction procedure, there will be more room beneath the soft tissue, which will aid lymph fluid circulation. The primary etiological theory for myofascial pain syndrome states that an inadequate supply of oxygen and blood to the tissue causes an energy crisis to occur.[26] The space correction approach of using kinesiology tape has the potential to increase patient tolerance of the pain pressure threshold by reducing pressure on the pain sensors, reducing inflammation in the surrounding tissue, and improving circulation.[26] By relieving fascial lesions, or TrPs, linked to MPS, lymph fluid drainage can help hasten tissue recovery.

Another common method of using kinesiology tape is using the direction of the tension to either facilitate or inhibit a muscle.[26] The practitioner starts by applying very little stress with the tape along the belly toward the origin, which encourages the muscle to relax and prevents it from contracting too much. The Golgi tendon organ (GTO), a physiological structure that exists where the muscle and tendon meet, provides the basis for this inhibitory method. The GTO prevents over contracting muscle by inhibiting one muscle while simultaneously stimulating the opposite muscle. When the goal is to inhibit muscle fiber contraction, clinicians apply from the muscle insertion to the origin. Contrarily, by placing tape from the muscle origin to insertion, the facilitation technique, aids in muscular contraction.[26] Despite the fact that the procedures are different, the facilitation and inhibition of muscle movement both provide advantages, such as enhanced lymph flow.[26] By directing a muscle to fire when desired, the facilitation or inhibition applications can also be used to enhance proprioception and balance. Depending on the technique used, the tape is said to give the tissue a biofeedback mechanism that allows it to either contract or relax after receiving a neurological stimulation.[26] Clinicians can use a variety of tape application techniques depending on the desired result. However, the limited database of peer reviewed research studies and the need for a desired methodology leads to conflating evidence not conducive to clinical recommendations.

2.4.4. Kinesiology Tape and Myofascial Pain Syndrome

Although it is under investigated, kinesiology tape has turned into a treatment choice for patients with several muscle pathologies or pain syndromes, explicitly MPS. The supposed impact kinesiology tape has on muscle inhibition and facilitation, soft tissue arrangement, space creation, and circulation are similarly valuable in treating side effects related to MPS.[23,26,29,30,57,60,61] The side effects of myofascial pain syndrome, as talked about already, emerge from the fascial layer of tissue. Researchers investigating kinesiology tape as a treatment technique for MPS use the space creation strategy or, on a more regular basis, than muscle facilitation or inhibition technique. Different strategies for application utilized in the writing, in any case, the writing does not mirror a standard technique that is best in treating MPS and related TrPs.[26]

Using the space creation strategy to apply kinesiology tape, scientists directed a randomized, sham-controlled review to contrast kinesiology tape with an elective sort of taping named cross taping.[29] Participants (N=73) were recruited by means of convenience sampling from a clinical school setting and were affirmed to have asymptomatic, idle TrPs in the upper trapezius (UT).[29] Notably, dormant and asymptomatic TrPs as inclusion criteria diverges from past studies in regards to MPS; more often the inclusion criteria incorporate suggestive TrPs with pain for an extended period of time.[29,31–34,56] Overall, most of the subjects were female (n=68) (P=0.0701), which could be because of convenience sampling, however no measurable investigation of the nominal data point is accounted for in the results.[29]

After randomization into one of three groups, cross tape (n=24; 20.2 ± 1.1 years), kinesiology tape (n=25; 20.6 ± 1.5 years), or sham tape (n=24; 19.9 ± 0.8 years), the subjects were surveyed for electrical activity of the UT through surface electromyography, cervical ROM, as well as pain levels by means of VAS. All outcome measurements were gathered pre-tape application, post-tape application, and at a 24-hour follow-up; subjects were expected to wear the tape for 72 sequential hours. The cross tape is depicted as comparative in material to kinesiology tape however applied in more modest strips with a woven pattern straight over a TrP. The strategy for space creation used to apply the kinesiology tape (Nitto Denko K-Active Tape) was portrayed by the scientists as a star-shape comprising of four straight strips applied to the UT with 50% tension.[29] The tape applied to the sham group was a nonelastic clinical tape, guaranteeing no remedial impacts were applied to the tissue. Albeit not explicitly recognized as a Certified Kinesio Tape Practitioner (CKTP), all taping methods were applied by a confirmed kinesiology tape clinician. It is important to be mentioned that the patients were blinded to the sort of tape applied, yet the clinician was not, allowing for the chance bias error on part of the researcher.[29]

Mean values of EMG activity of the UT muscle were recorded alongside cervical ROM, and pain utilizing a zero to ten VAS. To analyze the differences between the three groups at pre-, post-, and follow-up, a repeated Friedman ANOVA was conducted; EMG scores of the UT had no measurable significance in the cross-taping group (P=0.1152), kinesiology tape group (P=0.3260), or sham tape group (P=0.0542). In any case, the inverse was valid for VAS scores and cervical flexion; there were huge contrasts between pre-, post-, and follow-up for each group in range of motion and pain (Table 4).[29] Finally, an independent Kruskal-Wallis ANOVA was utilized to determine the distinctions between groups. Researchers reported no statistically significant differences between any of the groups in almost every outcome measure; although, the kinesiology tape group had a greater improvement in VAS scores when contrasted with the shame tape group (P=0.0018).[29]

Despite the fact that kinesiology tape is theorized to work on all of the outcome measures the clinicians had in this review, it is unsure why the scientists picked the space creation method to influence change on muscle activity and ROM.[26,29] It is hypothesized an overabundance of lymph liquid inside the tissues keeps muscles from contracting to work with the pump that mobilizes the fluid; however, the favored technique for modifying muscle activity and range of motion is the facilitation or inhibition technique.[26] Furthermore, Kinesio Taping Association International (KTAI) proposes using a fascial application in occurrences of fascial malalignment. In view of this limitation, no statistically significant changes were seen in muscle EMG and the authors conclude kinesiology tape has no effect on muscle activity.[29] Despite these lacking findings, a comparative report using a different strategy of tape application might yield different outcomes.

Table 4. Friedman ANOVA *P*-values for VAS and Cervical Flexion in the Cross Tape, Kinesiology Tape, and Sham Tape Groups[29]

	Cross tape group	Kinesiology tape group	Sham tape group
VAS	*P*=0.0001	*P*=0.0001	*P*=0.0011
Cervical flexion	*P*=0.0000	*P*=0.0000	*P*=0.0004

Researchers utilized the inhibition Kinesio® Taping method in an attempt to treat active ROM and pain related to TrPs in the piriformis muscle.[23] Despite naming the technique, the authors did not report the brand of kinesiology tape used in the approach. Enlisted through convenience sampling, subjects (N=51) were randomized into an experimental (n=33; 42.2 ± 15.8 years) or control group (n=18; 42.7 ± 12.7 years) based on order of inclusion. A clinician confirmed piriformis involvement utilizing several diagnostic tests.[23] Based on the evaluations, thirty one subjects present with right piriformis MPS and the remainder twenty subjects with left piriformis MPS. Outcome measurements of pain by means of VAS, and active hip internal rotation (IR) of the affected side via goniometry were recorded at three points in time: pre-tape, ten minutes post-tape, and 72-hour post-tape. The researchers reported using an inhibitory taping method by pulling tension on the tape from origin to insertion on the affected piriformis of the kinesiology tape group.[23] However, this application of the inhibition taping method is fundamentally incorrect. If the desired outcome is to relax or inhibit the muscle fibers, opposite direction of tension is indicated, pulling the tape from muscle insertion to origin. By pulling tension from origin to insertion, the researchers, in actuality, applied a muscle facilitation taping method. In side-lying with the patient's affected side facing up, the hip was positioned in flexion, adduction, and internal rotation. The base of a Y-shaped segment of tape was adhered to the opposite side of the sacrum with no added tension. The top tail of the tape was then applied to upper piriformis, finishing at the greater trochanter of the femur.[23] Finally, the bottom tail was applied to below the TrP, on the lower half of the piriformis, finishing at the same mark on the greater trochanter. Researchers explain a modification to the method called 'unloading,' which included the clinician lifting the gluteal tissue encompassing the TrP while adhering the second tail of the tape. Other than the muscle being unloaded, the authors do not express a rationale to this modified technique.[23] Regardless, the taping strategy utilized by the researchers was executed incorrectly, voiding the significance of the results.

The researchers use a repeated measure ANOVA to analyze the significant differences between the experimental and control groups for pain and ROM at three points of time (pre-, post-, and 72- hours post-). Although there was no statistically significant difference found between groups, researchers report significant correlation between point of time and group assignment for both outcomes, VAS [F (1,49) = 8.75; *P*= 0.001] and hip IR [F (1,49) = 4.68; *P*=0.027].[23] Additionally, there are significant differences between pre-, post-, and 72-hours follow-up scores for both outcome measures, VAS [F (1,49) = 8.82; *P*=0.001] and hip IR [F (1,49) = 3.1; *P*=0.049]. It is unknown how much effect the unloading modification had on the results and should be considered a limitation because it is slightly altered from the, erroneously reported, inhibition technique. Based on the results, the researchers support the effectiveness of the inhibition Kinesio® taping technique, modified with unloading, in treating pain and active ROM associated with TrPs in the piriformis muscle.[23]

Another group of researchers who used the muscle inhibition Kinesio® taping method to investigate the effects of the technique on muscle strength and perceived pain rather than ROM.[56] All subjects were being treated at a rehabilitation center and were recruited via a biased, nonprobability convenience sampling. Subjects (N=37) with sedentary desk jobs, subsequent neck pain, and TrP of the trapezius muscle were randomized into treatment (n=20; 30.0 ± 4.9 years) or sham groups (n=17; 33.9 ± 8.5 years). All subjects were evaluated for trapezius strength and perceived pain following a Kinesio® Tape application.[56] The treatment group had tape applied with the muscle inhibition method by taping the muscle from insertion to origin, while the sham group had no therapeutic methods applied to the tape to act as the control. To properly apply the inhibition Kinesio® Tape method, the patients' neck was placed in lateral flexion in the opposite way of the affected trapezius muscle. The tape was anchored inferior to the acromion, and placed on a maximal stretch along the muscle belly prior to ending the tail of the tape at the muscle origin, or at the patient's hairline.[56] The tape was applied to both groups at the beginning of the week, staying on for three days. Throughout the entire study, the tape was applied to each patient two times, with one day rest between applications.

All participants were screened for pain using a VAS as well as pain pressure threshold (PPT) using an algometer.[60] Furthermore, strength of shoulder elevation, specific to the trapezius muscle was obtained using dynamometry. Each outcome, pain, PPT, and strength, were measured at three moments in time; pre-intervention, immediately post-intervention, and at a one-month follow-up appointment. In addition, participants in both groups were asked to complete an at-home stretching and strengthening program.[60] Comparing VAS scores between the two groups at the one-month follow-up and pre-intervention, there was a statistically significant difference in favor of the treatment group ($P<0.05$). Additionally, within both groups, VAS scores significantly reduced ($P<0.0001$). PPT scores were significantly different when comparing measures for immediately post-intervention to one-month follow-up, also in favor of the treatment group. ($P<.0.05$).[60] Similar to the VAS scores, PPT scores improved within both the treatment group ($P<0.0001$) and the control group ($P<0.05$). Differing slightly, trapezius strength was found to be improved significantly in only the treatment group ($P\leq0.0001$). Despite finding significant improvements in several categories that favored the treatment group, the taping intervention was combined with an at-home therapy program.[60] Therefore, the effects portrayed in the significant outcomes may be explained solely due to the at-home exercises, rather than the Kinesio® Tape alone. If, and only if, the assumption is made that there was total compliance within both groups, the conclusion is supported that Kinesio® Taping using the inhibition method of application could provide significant relief for patients suffering from myofascial pain of the trapezius muscle.[60]

The effectiveness of Kinesio® Tape combined with manual pressure release (MPR), was compared to MPR alone, on treating TrPs.[30] In this single-blinded, randomized control trial, researchers recruited thirty one subjects and randomly assigned them into two groups: manual pressure release (n=16; 30.0 ± 6.5 years) or manual pressure release with a kinesiology taping intervention (MPR/MKT) (n=15; 28.0 ± 4.6).[30] Researchers applied Kinesio Tex® Tape using the insertion to origin, or the inhibition method. A Y-shaped piece of tape with two tails was adhered with the patient in an upright seated position with the neck laterally flexed to the affected side.[30] The tape was anchored at the acromion process, the insertion point for the upper trapezius, ending the tape application at the upper cervical spine. The two tails of the Y-strip encircle the muscle belly; no level of tension was reported by the researchers. Subjects wore the tape for three days; the tape was then re-applied with the same technique by the same clinician for another four days, for a total of seven days.[30] The second intervention, MPR, was performed on active TrPs of the upper trapezius, identified by a therapist, who applied pressure to the fascial adhesion with the pad of their thumb. Clinician applied pressure was increased gradually until the patient reported pain as a seven, on a zero to ten scale. Even pressure, at this moderate level of perceived pain, was sustained until the therapist detected a release of the adhesion.[30] Then, an increased pressure was applied, until the same moderate pain level was reported by the subject. This manual therapy technique was repeated until the patient no longer perceived pain or 60 seconds had passed. Although detailed, this manual therapy technique is entirely subjective to the patient's pain pressure threshold.[30] Moreover, the therapist performing the MPR may potentially experience fatigue and therefore cannot guarantee an evenly sustained pressure throughout the intervention.

The primary outcome measures were pain (VAS), pain pressure threshold (algometer), muscle stiffness (myotonometer), and muscle contraction (mechanomyography (MMG)) of the upper trapezius muscle. Outcome measurements were collected pre-intervention, post-intervention, and at a seven-day follow-up appointment.[30] Within both MPR and MPR/MKT groups, PPT improved significantly (d=1.79; *P*<0.005). Additionally, strength of muscle contraction was found to be significantly higher in favor of the MPR/MKT group (*P*<0.05). The same was true for muscle stiffness, measured via myotonometer, which was analyzed using a Mann-Whitney test and yielded statistically significant differences within the MPR/MKT group (0.27 mm to 0.49 mm).[30] Based on these results, the authors concluded that both MPR and the Kinesio® Tape inhibition method are successful in treating symptoms associated with MPS in the upper trapezius. However, they also noted that the treatments became most effective when used in combination of one another. It is difficult to form accurate clinical recommendations based on the results regarding Kinesio® Tape in this study because of the combined intervention limitation.[30]

Research on the use of pain pressure threshold as a diagnostic tool or to identify a clinically meaningful change is also lacking. Although PPT averages have assisted in establishing standard values in various muscles, there is no specific parameter that separates diseased from healthy tissue.[50] To create a benchmark bone to muscle tolerance ratio, various guidelines for pain tolerance have been established.[63] This entails measuring a patient's PPT in relation to a bone, such as the forehead, directly before comparing the result to the PPT of muscle, which, in the absence of pathology, ought to be higher than bone. This bone muscle ratio can assist clinicians determine whether a patient has soft tissue hypersensitivity if their general pain tolerance is poor.[63]

Further supporting the clinical applicability, Walton et al.[64] reported important conclusions regarding PPT used to detect changes over time. The authors note that in patients with very low PPT at baseline their PPT may not accurately detect exacerbation or decline in PPT. Overall, the PPT is better at identifying changes with a higher initial baseline. Thus, it would lead to more variance in studies that include a population of non-healthy individuals with existing pathologies whose PPT may experience a greater change over time with therapeutic intervention.

The same investigator found that the algorithm was better at detecting changes in existing pathologies rather than excluding said pathologies, with high specificity of the tool (0.92) and negative predictive value (0.86).[64] Findings include minimal detectable changes and overall low or hypersensitive pain pressure thresholds within those affected by a chronic pathology.[64] Future studies should attempt to analyze the algorithm using symptomatic versus asymptomatic participants.

3. DISCUSSION, CONCLUSION AND RECOMMENDATION

This paper reviewed the effect of Kinesio® tape fascial correction on subjective pain pressure threshold of palpable iliotibial band (ITB) trigger points (TrPs). This paper provided insight into kinetic chain implications of untreated myofascial pain syndrome, a subject that lacks literature.

Current scientific literature regarding Kinesio® Tape as a treatment intervention for MPS and iliotibial band TrPs contains flawed methodologies and taping techniques and has produced inconsistent evidence. Fascial taping is recommended to repair the disorganized fiber development and inappropriate neurotransmitter flow because of the pathophysiological and anatomical makeup of myofascial TrPs. The fascial layer of tissue has not been considered in prior research on kinesiology tape as a therapeutic option for MPS. Instead, authors used a variety of techniques[26,55] like space creation[54], facilitation[23,26], or muscular inhibition[23,59,62] in an effort to reduce TrPs symptoms. To compare specific fascial correction techniques to other indicated fascial procedures offered by Kinesio® Tape, additional research should be conducted.

Future studies investigating pain pressure thresholds in the TrP should attempt to include objective data point. Ultrasound diagnostics to visualize changes in the TrP should also be explored further. Additionally, future researchers should consider applying another brand of kinesiology tape using the same vibratory fascial taping technique to reveal differences with Kinesio Tape®. There is a sensorimotor stimulus associated with the skin tape, which may have a placebo effect on pain in participants, who experience an increase in pain threshold when the tape stimulus is removed after 48 hours.

The advantage of utilizing inhibition technique over facilitation, or vice versa, for the treatment of MPS is not explored in kinesio tape literature. TrPs related to MPS can form because of overstimulation or insufficient muscle activation, as previously referenced. Without first comprehending the etiologic origin of the TrPs, clinicians cannot make an informed choice between facilitation or inhibition methods.

Overall, there are many kinesiology tape application techniques, which clinicians can choose from dependent on their preferred therapeutic outcome. However, the lack of consistent methodologies across the literature hinders the evidence from supporting one clear method as the most effective to treat MPS or associated TrPs. There are multiple alternative methods of kinesiology tape application designed specifically for fascial pathologies, however researchers have not employed the technique in clinical trials, instead maintaining the use of conventional methods.[23,29,30,60,61] This further limits the already insufficient literature for kinesiology tape as a clinically effective treatment for MPS.

At this point in time, there is not enough peer reviewed research specific to kinesiology taping for fascial restrictions and MPS to make a clinical recommendation. There is, however, evidence that fascial taping has positive impact on patient perceived pain. With this knowledge, clinicians can confidently defend the use of kinesiology taping to treat insidious pain syndromes believed to be caused by fascial restrictions. The clinician using these techniques should be educated and certified in the applications in which they chose to use. More research is necessary specifically to determine the effectiveness of kinesiology tape application for the treatment of latent TrPs and MPS in order to make an effective clinical recommendation.

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APPENDIX. SUMMARY OF REVIWED ARTICLES

Author, Year	Population, Duration of Study, or Participant Characteristics	Type of Study	Aim of Study	Key Findings
Kristen Jackson; 2016	N=30; 7 days; mean age KT group 19.9, control group 20.9, individuals with a history of at least 1 lateral ankle sprain and having experienced ankle instability in the last 6 months.	Pretest-posttest repeated measures control group design.	To determine if KT can help with balance deficits associated with chronic ankle instability (CAI).	The KT improved balance after it had been applied for 48 hours when compared with the pretest and the control group. Balance improvements were retained after the tape had been removed for 72 hours.
Victoria Wilson; 2016	N=17; 5 days; mean age 23.3, healthy individuals who participated in moderate exercise at least 2x per week, free of musculoskeletal injury.	Pretest-posttest repeated measures control group design.	To investigate the immediate and long-term effects of the prescribed application (for facilitation) of KT when applied to the dominant lower extremity of healthy individuals.	There were no significant differences for main and interaction effects between KT and sham groups for the balance and four hop tests.
Im-Rak Choi; 2018	N=18; 1 week; age 20 or older, free of limitations in activities of daily living due to knee pain.	Single-blind and cross-over study design.	To examine whether quadriceps strength differs depending on the kinesiology tape application direction, using isokinetic equipment.	There was a significant difference in muscle strength after taping, regardless of the kinesiology tape application direction. There were no significant differences in the peak torque of the quadriceps between the 2 kinesiology tape application directions.

Fahimeh Hashemirad; 2016	N=51; 3 days; mean age KT group 42.7 control group 42.2, subjects who had been directly referred by orthopedists for outpatient physical therapy. Diagnosis of involvement of piriformis with trigger points was confirmed.	Single blinded, pretest-posttest repeated measures control group design.	To determine the effects of KT on pain and hip joint range of motion (ROM) in individuals with myofacial trigger points in the piriformis muscle.	Significant improvement in pain and hip IR immediately post-application and at a 72-hr follow up in the KT group, while no significant change were found on dependent variables in the control group.
Adelaida Maria Castro-Sanchez; 2012	N=60; 5 weeks; mean age experimental group 50 control group 47, participants were required to have low back pain for at least 3 months.	Single blinded, randomized controlled trial with repeated measures placebo control group design.	To determine if Kinesio Taping reduce disability, pain, and kinesiophobia in people with chronic non-specific low back pain.	The experimental group had significantly greater improvement in disability; these effects were not significant four weeks later. The experimental group also had a greater decrease in pain than the control group immediately after treatment, which was maintained four weeks later. Trunk muscle endurance was also significantly increased at one week and four weeks.
Tomasz Halski; 2015	N=105; 24 hours; mean age CT group 20.2 KT group 20.6 control group 19.9, participants were individuals diagnosed with latent myofascial trigger points in the upper part of the trapezius muscle.	Single blinded, randomized controlled trial with repeated measures placebo control group design.	To determine how CT, KT, and medical adhesive tape (sham group) affect the subjective assessment of pain and resting bioelectrical activity of the UT muscle in patients with myofascial TrPs	No significant differences were observed in bioelectrical activity between pre-, post-, and follow-up results. In all three groups patients had significantly lower pain VAS score after the intervention.

Yu Wen Chao; 2016	N=31; 7 days; mean age MPR group 30 MPR/MKT group 28, subjects were required to meet criteria of myofascial TrPs in the upper trapezius muscle and had a normal neurological examination.	Single blinded, randomized controlled trial with repeated measures design.	To determine the effects of manual pressure release (MPR) alone or in combination with taping (MPR/MKT) in subjects with MTrPs. Outcome measures included: pain pressure threshold, muscle stiffness, and the vibration amplitude/frequency of muscle contraction.	VAS scores were significantly lower in the MPR group than in the MPR/MKT group immediately after intervention. In both groups, scores on the pain scale were lower after intervention and follow-up than at baseline. significant improvement on tissue displacement in the MPR/MKT group as compared to the MPR group after intervention and at follow-up. MMG amplitude was found to be significantly higher in the MPR/MKT group when compared to the MPR group at follow-up.
Katie Lyman; 2017	N=32; single session; mean age 20.7, participants were all recreationally active individuals with bilaterally healthy knees and no existing musculoskeletal conditions.	Pre-test/post-test prospective cohort study.	To determine whether the Kinesio® Taping Space Correction Method created a significant difference in patellofemoral joint space, as quantified by diagnostic ultrasound.	Statistically significant difference between pre- and post measurements of the patellofemoral joint space with a medium effect size. Pre-test/post-test measurements between the skin and the superficial patella were not statistically significantly different. Measurement between the skin and the patellar tendon also was not statistically significantly different.

Gulcan Ozturk; 2016	N=37; 1 month; mean age KT group 30 Control group 33.9, participants were individuals with neck/upper back pain for a duration of longer than 2 weeks who had active myofascial TrPs in the upper trapezius muscle.	Single blinded, randomized controlled trial with repeated measures placebo control group design.	To determine the short- and mid-term effects of Kinesio taping on the trapezius muscle in individuals with myofascial pain syndrome.	The mean changes in VAS scores were significantly different between groups at 1-month post-treatment compared with pre-treatment scores in favor of KT group. The mean changes in algometry scores were significantly different between groups at 1-month compared with immediately after tape application in favor of KT group. The mean changes in trapezius muscle strength were significantly different between the groups immediately after tape application compared with pre-application in favor of KT group.