Osteopathic Treatment and Dry Needling for Knee Osteoarthritis

A Doctoral Thesis

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by

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Osteopathic Treatment and Dry Needling for Knee Osteoarthritis

Background

Osteoarthritis (OA) is a type of arthritis and is a chronic and degenerative disease that occurs when the cartilage that lines the joint is worn resulting in bones rubbing against its other causing pain, stiffness, loss of function or disability (Salih, Alsalihi, Mahboub, Jasim, & Almutawa, 2024), (Al-Saleh, et al., 2022), (Al-Omari, et al., 2023) and quality-adjusted life-year losses (see review in (Vitaloni, et al., 2020)). This is one of the most common diseases worldwide and one of progressive type of musculoskeletal disorder that is characterised by inflammation and major structural damage to the tissues of one or more joints (Thysen, Luyten, & Lories, 2015). Individuals with OA presents varying levels of mobility issues, with pain experienced with this disability ranging from mild and sporadic. Performance of daily activities can be affected, albeit minimally, whilst some experiences chronic pain coupled with progressive structural damage and functional loss, where greater disability are manifested with those with mental health conditions and mortality can occur for lack of mobility (e.g., walking) or can no longer live independently (see review in (Vitaloni, et al., 2020)).

OA cases worldwide has steadily increased over the years such that from 1990 to the latest data available from sources (i.e., up to 2021 as presented within the Global Burden of Disease Study by the Institute of Health Metrics and Evaluation (IHME)), impacting around 137% of the global population (Institute for Health Metrics and Evaluation (IHME), 2024) presenting significant impacts to health and the broader society (Al-Saleh, et al., 2022).

Available data demonstrated the highly prevalent nature of this debilitating disease where the total affected individuals of 256 million, representing 4.93% of the total global population for the year 1990 has affected over 606 million or 7.96% of the global population, mostly women, in

2021 (Institute for Health Metrics and Evaluation (IHME), 2024). Such that, OA is known as the third most fast rising condition worldwide after diabetes and dementia (Vitaloni, et al., 2020).

Among the types of OA, those affecting the knee joints are the highest prevailing among almost 375 million individuals in 2021, an increase of approximately 134% from 1990 total of almost 160 million (Institute for Health Metrics and Evaluation (IHME), 2024).

Management of knee OA in most patients involve the use of a combination of pharmacological and nonpharmacological therapies, including physical therapy modalities and acupuncture, and the use of supplements, which have been found effective particularly in cartilage reconstruction (Nejati, Farzinmehr, & Moradi-Lakeh, 2015).

Study Objectives

The main objective of this study is to present a viable combination of osteopathic and dry needling treatments for the effective relief of pain, restore functional mobility, and in principle allow for the treatment of predisposing mechanical and physical problems with the overall goal of preventing further deterioration of the knee condition and improving the overall quality of life of affected individuals.

Review of Literature

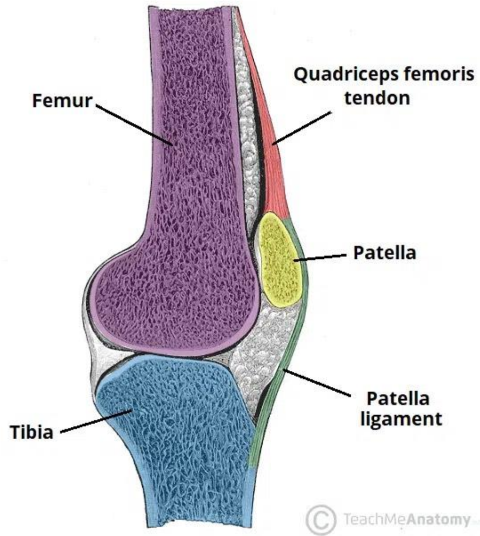
Anatomy of the Knee

The knee joint is the largest joint in the human body. Anatomically, the knee joint comprises of opposing bones that are shielded by cartilage that allows for the smooth contact between the bones whilst reducing the risk of damage to the bone surfaces. Such that it represents as a hinge type synovial joint, which mainly allows for flexion and extension (and a small degree of medial and lateral rotation). The bones and cartilage are enclosed in a cavity lined by the synovium, a layer that produces fluid for lubrication and nutrition.

Articulating Surfaces of the Knee

It is formed by articulations between the patella, femur and tibia as illustrated in Figure 1.

Figure 1. The Anatomy of the Knee



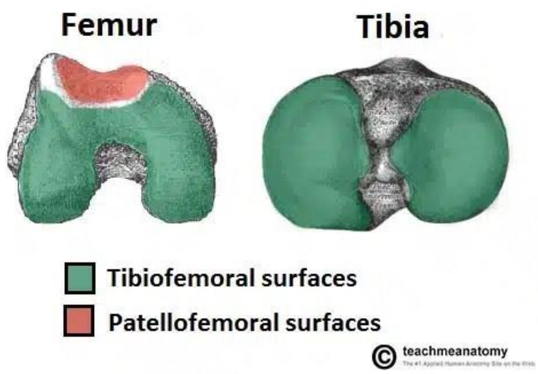
Source:

The joint surfaces are lined with hyaline cartilage and are enclosed within a single joint cavity.

- Tibiofemoral – medial and lateral condyles of the femur articulate with the tibial condyles. It is the weight-bearing component of the knee joint.
- Patellofemoral – anterior aspect of the distal femur articulates with the patella. It allows the tendon of the quadriceps femoris (knee extensor) to be inserted directly over the knee – increasing the efficiency of the muscle.

As the patella is both formed and resides within the quadriceps femoris tendon, it provides a fulcrum to increase power of the knee extensor and serves as a stabilising structure that reduces frictional forces placed on femoral condyles.

Figure 2. The Articulating Surfaces of the Knee



Neurovascular Supply

The blood supply to the knee joint is through the genicular anastomoses around the knee, which are supplied by the genicular branches of the femoral and popliteal arteries.

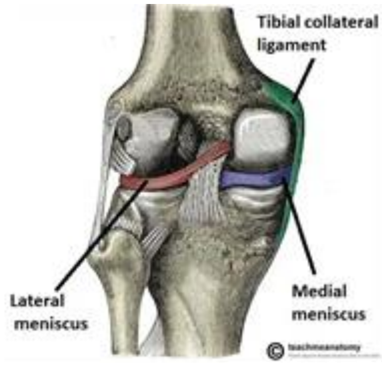
The nerve supply, according to Hilton’s law, is by the nerves which supply the muscles which cross the joint. These are the femoral, tibial and common fibular nerves.

Menisci

The medial and lateral menisci are C-shaped fibrocartilage rings located within the knee joint. They serve two main functions:

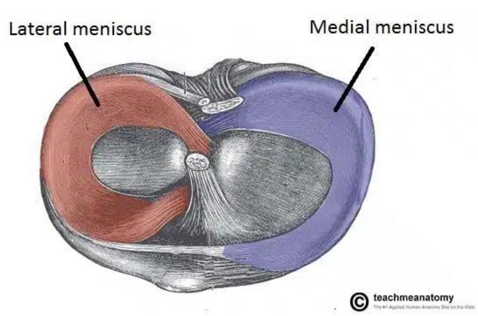
- Deepens the articular surface of the tibia – increasing the stability of the joint.
- Acts as shock absorbers– increasing surface area to further dissipate forces that are transmitted across the joint.

Figure 3. The Menisci



They are attached at both ends to the intercondylar area of the tibia. In addition to this attachment, the medial meniscus is also fixed to the medial collateral ligament and the joint capsule. Damage to the medial collateral ligament is often associated with a medial meniscal tear. The lateral meniscus is smaller and does not have any additional attachments, rendering it more mobile.

Figure 4. Cross Section of the Menisci



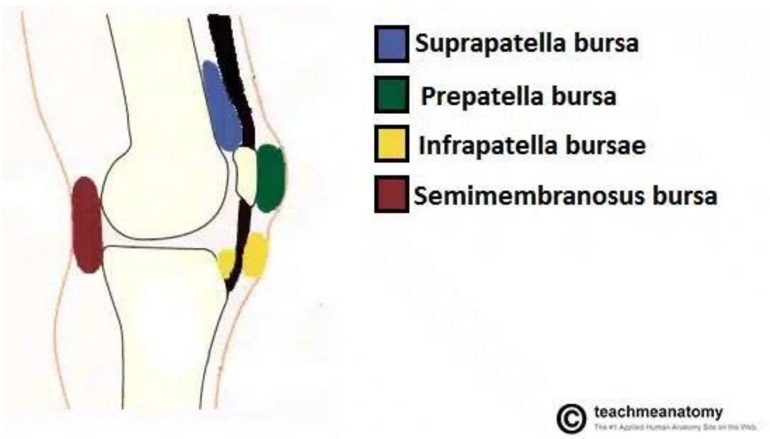
Bursae

A bursa is a sac skin during movement. There are four main bursae found in the knee joint:

- Suprapatellar bursa – located between the quadriceps femoris and the femur.
- Prepatellar bursa – located between the apex of the patella and the skin.

- Infrapatellar bursa – split into deep and superficial. The deep bursa lies between the tibia and the patella ligament. The superficial lies between the patella ligament and the skin.
- Semimembranosus bursa – located posterior to the knee joint, between the semimembranosus muscle and the medial head of the gastrocnemius.

Figure 5. The Bursae



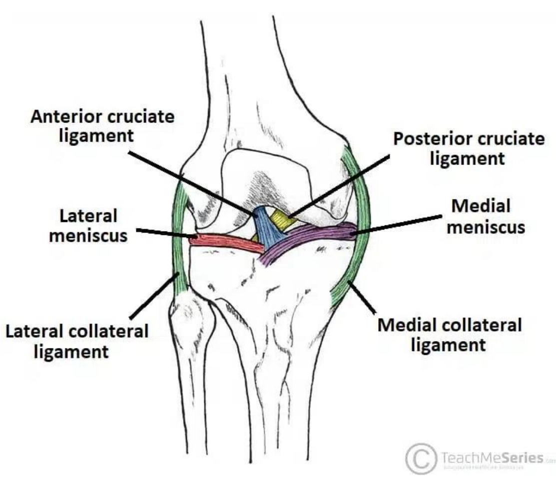
Ligaments

The major ligaments in the knee joint are:

- Patellar ligament – a continuation of the quadriceps femoris tendon distal to the patella. It attaches to the tibial tuberosity.
- Collateral ligaments – two strap-like ligaments. They act to stabilize the hinge motion of the knee, preventing excessive medial or lateral movement
- Medial collateral ligament – wide and flat ligament, found on the medial side of the joint. Proximally, it attaches to the medial epicondyle of the femur, distally it attaches to the medial condyle of the tibia.

- Lateral collateral ligament – thinner and rounder than the medial collateral ligament. It attaches proximally to the lateral epicondyle of the femur and distally to a depression on the lateral surface of the fibular head.
- Cruciate Ligaments – these two ligaments connect the femur and the tibia. In doing so, they cross each other, hence the term ‘cruciate’ (Latin for like a cross)
- Anterior cruciate ligament – attaches at the anterior intercondylar region of the tibia where it blends with the medial meniscus. It ascends posteriorly to attach to the femur in the intercondylar fossa. It prevents anterior dislocation of the tibia onto the femur.
- Posterior cruciate ligament – attaches at the posterior intercondylar region of the tibia and ascends anteriorly to attach to the anteromedial femoral condyle. It prevents posterior dislocation of the tibia onto the femur.

Figure 6. The Ligaments Associated with the Knee

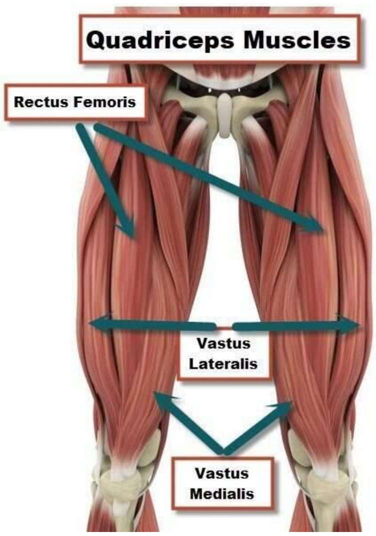


Muscles and Tendons of the Knee

Many muscles affect the knee, but the main muscles that allow for the knee to perform its main functions are:

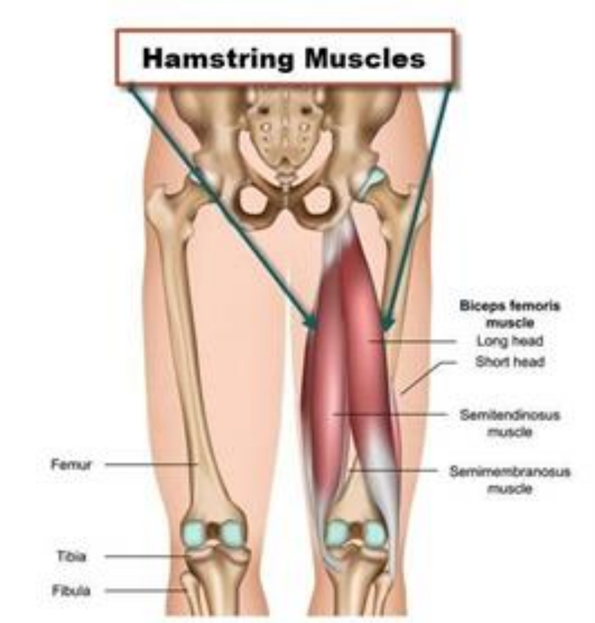
- Quadriceps: A group of 4 muscles that sits on the front of the thigh. These muscles are responsible for allowing the knee to straighten. This movement is necessary for standing from a seated position, bringing your leg forward when walking, and kicking a ball! The two patellar tendons attach the quad to the patella. These tendons can also rupture during sports.

Figure 7. The Diagram of the Quadriceps Muscles



- Hamstrings: A group of 3 muscles sits at the back of the thigh and allows for the knee to bend. These muscles are responsible for lifting your foot to walk. The hamstring muscles can be strained or torn during sport activities. The athlete is described by "pulling up" while running. This is a classic sign of a hamstring strain.

Figure 8. The Diagram of the Hamstring Muscles



Medical Presentation

Osteoarthritis

Osteoarthritis (OA) is confined to one or more synovial joints and its surrounding soft tissues. The progressive destruction of articular cartilage and the formation of bone at the margins of the joint. OA is now recognized as a disease involving the entire joint including the periarticular musculature Accordingly, the impairment, activity limitations, and participation restrictions related to OA extend far beyond the perimeters of the synovial joint (see Figure 9).

Figure 9. Stages of Osteoarthritis

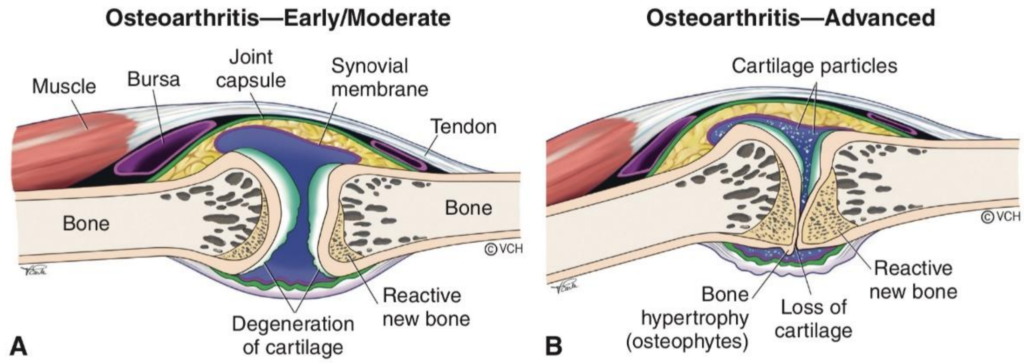


Figure notes:
Early joint changes are characterized by superficial damage to articular cartilage and mild inflammation
Moderate changes include joint space narrowing with full thickness damage to cartilage and thickening of the subchondral bone
Advance joint changes are marked by bony hypertrophy (marginal osteophytes) significant joint space narrowing and possible angulation (deformity) (Source: Mary Pack Arthritis Program Vancouver Coastal Health)

Osteoarthritis is the most common type of arthritis affecting the knee joint. It is a degenerative wear and tear type that occurs most often in people of 50 years of age older it may occur in younger people as well. The cartilage in knee joint gradually wears away and becomes frayed and rough and the protective spaces between the bones decreases. It can result in bone to bone rubbing which produces painful bone spurs.

Symptoms

A knee joint affected by arthritis may be painful and inflamed. Generally, the pain develops gradually over time, although sudden onset is also possible. There are other symptoms, as well:

- The joint may become stiff and swollen, making it difficult to bend and straighten the knee.
- Pain and swelling may be worse in the morning, or after sitting or resting.

- Vigorous activity may cause pain to flare up.
- Loose fragments of cartilage and other tissue can interfere with the smooth motion of joints. The knee may lock or stick during movement. It may creak, click, snap, or make a grinding noise (crepitus).
- Pain may cause a feeling of weakness or buckling in the knee.
- Many people with arthritis note increased joint pain with changes in the weather.

Etiology and Epidemiology

In the development of OA, the main risk factors include age (older than 55 years), female gender (considering over 60% of those affected are women), obesity, anatomical factors, muscle weakness, and joint injury (occupation/sports activities) (see review in (Sen & Hurley, 2023)). OA, whilst classically presents with joint pain and loss of function; clinical variability is prevalent and manifest as asymptomatic oftentimes presenting as incidental finding to a more devastating and permanently disabling disorder (Sen & Hurley, 2023).

Current Management for Knee OA

Osteopathy

What is osteopathy? Osteopathy was discovered by American doctor Andrew Taylor Still. It is defined as a system of diagnosis and treatment for a wide range of medical conditions. It works with the structure and function of the body and is based on the principle that the well-being of an individual depends on the skeleton, muscles, ligaments and connective tissues functioning smoothly together.

Osteopaths are highly trained professionals with particular expertise in the musculoskeletal system – the muscles, joints and their relationship with other systems of the body. They often use manual hands-on therapy to help to improve mobility, relieve tension, increase blood flow and optimize physical function.

Philosophy of Osteopathy.

1. The body is a unit. Any dysfunction one joint affect the entire body
2. Structure and function are interrelated
3. The body is self regulating negative feedback moving up n down keep all level and normal ranges keep all balance
4. the body is designed to defend and heal itself, protect and shield us healing is a process
5. when the bodies ability to adapt disrupted the internal environment loses integrity maintain is disintegrate
6. All treatment must be rational and base all principle

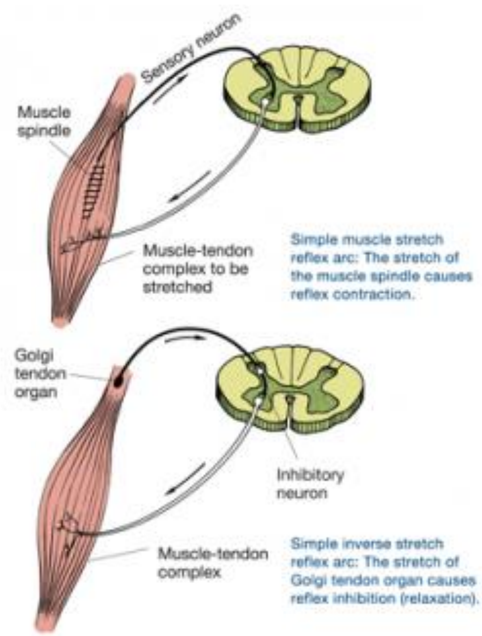
Osteopathic Techniques. A wide variety of osteopathic technique protocols were introduced which are based upon the osteopathic philosophy of restoration of movement. It allows body's structure to operate with maximum capability and restore loss of function, predominantly, freedom from restrictions allows the body own healing mechanism to bring about a lasting quality of healing.

Examples of osteopathic techniques include cranial osteopathy, visceral osteopathy, strain/counter strain technique, manual mechanics therapy, facilitated positional release, ligamentous tension technique, joint mobilization, osteoarticular technique, stills technique, muscle energy technique, among others. The muscle energy technique which has been utilized in this study is further detailed in the following sections.

Muscle Energy Technique

Muscle Energy Technique (MET) is a technique that was developed in 1948 by Fred Mitchell, Sr, D.O. It is a form of manual therapy, widely used in osteopathy, that uses a muscle's own energy in the form of gentle isometric contractions to relax the muscles via autogenic or reciprocal inhibition and lengthen the muscle. MET is an active technique in which the patient is also an active participant. MET is based on the concepts of Autogenic Inhibition and Reciprocal Inhibition as illustrated in Figure 10. If a sub-maximal contraction of the muscle is followed by stretching of the same muscle it is known as Autogenic Inhibition MET, and if a submaximal contraction of a muscle is followed by stretching of the opposite muscle, then this is known as Reciprocal Inhibition MET.

Figure 10. The Mechanism of the Muscle Energy Technique



Mechanism of the MET. METs take advantage of the physiologic mechanisms of post-isometric relaxation and reciprocal inhibition, primarily to improve musculoskeletal function and reduce pain. MET is "direct" or "indirect" for a given joint based on the indication.

Post-isometric Relaxation. Golgi tendon organs (GTOs) are mechanoreceptors in most skeletal muscles. They are sensitive to muscular contractile force, and in contrast to muscle spindles, muscle stretches rarely and inconsistently activate GTOs. These encapsulated bundles of collagen are innervated by fast-conducting type Ib afferent fibers and are present at muscle-tendon or muscle-aponeurosis junctions; they attach to an individual muscle fascicle tendon on one end, and the whole muscle-tendon or aponeurosis of the other. This positioning, described as "in-series," means the receptor is part of the functional unit and stands in contrast to the muscle spindle that operates adjacent to the functional unit "in parallel. GTOs are activated at high levels of force and hypothetically inhibit muscle activity, preventing musculoskeletal injury.

Physiologically, increased tension to the GTO prompts the activation of the type Ib afferent fibers that project to the spine, where they provide positive input on inhibitory interneurons that, in turn, add negative or inhibitory input on the efferent α-motor neurons that receive input from the cortex to the homonymous muscle. In effect, sufficient GTO stimulation can override the efferent output from the brain, leading to relaxation. This phenomenon is known as the "inverse stretch" or the "autogenic" reflex. Dr. Mitchell Jr. further postulated that there is a refractory state after an isometric contraction where passive stretching may be performed without a myostatic reflex opposition.

The patients are usually placed into the barrier and asked to contract against the clinician. They are then asked to relax. This phase is refractory, where a new barrier can be reached, and the process is repeated.

Joint Mobilization Using Muscle Force. This principle works off the Meniscoid theory as described above. A distortion of articulation and motion loss leads to reflexive hypertonicity of the muscles crossing the joint. The reflexive hypertonicity further compresses the dysfunctional joint surface and leads to the thinning of the synovial fluid layers and adherence of both joint surfaces. Treating the segment requires the maximum force the clinician can tolerate to "reseat" the joint and reflexively relax the hypertonic muscle.

Respiratory Assists. The clinician holds a fulcrum using the motion of the ribs or the subtle movement of the spine/pelvis during respiration, allowing the respiratory forces to work. This technique frequently treats somatic dysfunctions in the ribs and sacrum.

Reciprocal Inhibition. Muscle spindles are stretch-sensitive mechanoreceptors found in skeletal muscle. A muscle spindle is a bundle of striated, intrafusal muscle fibers within the fascicles of force-producing, extrafusal muscle fibers. "Fusal" derives from the term "fusiform," meaning spindle-shaped. Any stretch or change in the length of the extrafusal fibers results in a stretch of the intrafusal fibers, which is then detected in the equatorial and polar regions of the muscle spindle. This physiology stands in contrast to GTOs, which are relatively insensate to passive changes in length but respond to an increase in muscle force. Two afferents, primary (type Ia) and secondary (type II), measure the stretch sensation. A single Ia fiber is present, along with between 0 to 5 II fibers per spindle.

The Ia fiber is comparable in size and speed of transmission to the previously mentioned Ib fibers and supplies all intrafusal fibers in the spindle at the equatorial region. The exact function of type II fibers is less understood; however, these smaller fibers terminate on the polar ends of the spindle. Muscle spindles are unique among proprioceptors in that efferent fibers innervate them. These myelinated γ-motor neurons derive from the same efferents that supply the extrafusal muscle. Excitation of these γ-motor neurons does not affect overall muscle tension but appears to maintain tension on the muscle spindles to track the length of the extrafusal fibers effectively. Lastly, spindle afferents are tonically active, with an increased firing rate in response to passive stretch in a velocity-dependent manner.

Physiologically, stretch to a muscle fiber produces activation of Ia muscle spindle afferents that project to the spine and activate the efferent α-motor neurons and, subsequently, the γ-motor neurons of the homonymous muscle, leading to contraction of the intra- and extrafusal fibers. Simultaneously, the Ia fibers activate inhibitory interneurons in the spine to inhibit the α-motor neurons of the antagonist's muscle. This circuit is called the stretch reflex, believed to prevent muscle strain and support bipedal walking and posture.

This principle is used when contracting the antagonist to relax the dysfunctional agonist muscle.

Oculocephalogyric Reflex. The oculocephalogyric reflex approach to MET can gently treat an unstable segment in the upper cervical spine using eye motion. This reflex is not fully understood but is related to the doll's eye and vestibulo-ocular reflex. Nerves for the extraocular muscles are sent to the vestibular nuclei via the ophthalmic division of the trigeminal nerve. Information from the vestibular nuclei then travels down the medial and lateral vestibulospinal tract. The medial tract specifically goes to C1, which may branch into the suboccipital muscles, allowing motion within the suboccipital muscles. This approach is useful if the patient has severe pain in the upper cervical spine or if upper cervical instability is suspected. The patient is set up to look toward a stimulus to test the reflex.

Crossed Extensor Reflex. MET uses the concept of crossed extensor reflex in the extremities when muscle damage occurs. Voluntary contraction will inhibit the same contralateral muscle and activate the contralateral antagonist muscle. An example of the reflex is if one flexes their quads to lift their legs due to stepping on a nail, and the contralateral hamstring muscle contracts to help stabilize. During the signaling pathway, the efferent nerves will communicate with multiple interneurons at the level of the spinal cord, where one will relay the message to the contralateral agonist muscle to relax.

Isokinetic Strengthening. This approach to MET is to help strengthen the muscle. A concentric contraction is utilized, and the muscle can shorten at a controlled rate. It is advised to first treat any shortening of an antagonistic muscle before performing strengthening treatments. For example, the quadriceps may be weakened due to hypertonic/shortened hamstrings; treatment would begin with treating the shortened hamstring muscles followed by isokinetic quadriceps strengthening.

Isolytic Lengthening. This approach is used to lengthen a muscle shortened by contracture of fibrosis. An isolytic contraction occurs because the clinician's force overcomes the contracture of the patient. The clinician applies a vibratory motion while performing the technique, as there is anecdotal evidence that it can help break up fibrosis and circulation.

Coordinated Motor Movement. This approach to MET involves moving adjacent body parts to treat the somatic dysfunction. It is thought that muscle contraction during the motion of the adjacent regions will also affect the area of dysfunction. An example is the treatment of a bilaterally extended sacrum; the patient is asked to push the pelvis and leg to help treat the sacral dysfunction.

Pathology. The increased muscle tone purportedly treated by MET is comparable to that of the hypertonicity or spasticity that presents in upper motor neuron disease. Increased activity of the extrafusal muscle fibers is secondary to either increased activity of the muscle spindle or abnormal sensory processing in the spinal cord. In the former, increased activity of γ-motor neurons leads to abnormally shortened muscle spindles, resulting in a hyperexcitable state such that movement within the physiologic range of motion produces reflexive muscular contraction. Similarly, type II fibers are hypothesized to contribute to spasticity through direct α-motor neuron activation

Clinical Significance. As discussed above, MET primarily serves to improve the range of motion and reduce pain. These techniques are used by practitioner (osteopathic and allopathic) as well as physical therapists and chiropractors for primary or adjunctive therapy. In the case of the former, MET is commonly used to reduce pain secondary to hypertonicity in the back, neck, and other major joints. However, this modality may hypothetically treat nearly any joint in the body. As for the latter, MET, in addition to standard-of-care treatment and other osteopathic techniques, has been demonstrated to improve outcomes in conditions such as pneumonia and fibromyalgia. In these cases, the complementary effects are attributed to fascial stretching, which is proposed to improve lymphatic and hemodynamic function.

The effectiveness of MET is dependent on diagnosis, localization, and the amount of force used. Differentiating between a key lesion and a compensatory change in diagnosis is important. Treating the compensation will not correct the patient's presenting symptoms. Awareness of one lesion's fascial factors on another is also critical. Although a segmental diagnosis is identified, significant side bending restriction in the segment above actively causes fascial strain, potentially leading to treatment difficulty in the identified segmental somatic dysfunction. As in all aspects of osteopathy, diagnosing the patient accurately and considering the broader clinical context is essential.

Using an excessive amount of force is a common mistake that is made by those new to MET. When using excessive force, a larger group of muscles is engaged to help stabilize the segment being treated. Further stability in the treated segment will negate the effects of muscle energy. Using 5 to 10 pounds of force during MET is commonly taught. However, experienced clinicians use enough force to observe a change in the relevant segment without recruiting surrounding muscles.

Lastly, the localization of the force is more important than the amount of force. Position the body so the force applied is on the treated segmental joint. Clinicians should make subtle changes depending on the anatomic variability between individual patients. For example, the sacrum is known to have 3 transverse axes and 2 oblique axes. The middle transverse axis is where the sacrum moves about the innominate, and the inferior transverse axis is where the innominate moves against the sacrum. A clinician treating an anterior innominate would want to flex the hip until the inferior transverse axis is engaged. Flexing too much or too little will not engage the proper joint segment and decrease the chance of successful treatment.

MET with post-isometric relaxation is the most commonly used modality and entails the following steps:

- The target joint or muscle barrier is isolated through joint positioning, generally to a pathologic barrier.
- Follow with active muscle contraction by the patient in a specific direction, generally away from the restriction, for a specified period against clinician-applied counterforce. Conventionally, the amount of force generated by the patient should be the maximum amount comfortably tolerated by both the patient and the clinician.
- Have the patient relaxation of the contracted muscle.
- Use passive movement of the patient's anatomy toward a new pathologic barrier.

- Repeat steps 1 to 4 as tolerated until physiologic pain is sufficiently relieved, or the patient achieves the desired range of motion.

Indication. Muscle Energy Techniques can be used for any condition in which the goal is to cause relaxation and lengthening of the muscles and improve range of motion (ROM) in joints. Muscle energy techniques can be applied safely to almost any joint in the body. Many athletes use MET as a preventative measure to guard against future injury of muscles and joints. It is mainly used by individuals who have a limited ROM due to facet joint dysfunction in the neck and back, and for broader areas such as shoulder pain, scoliosis, sciatica, asymmetrical legs, hips or arms, or to treat chronic muscle pain, stiffness or injury.

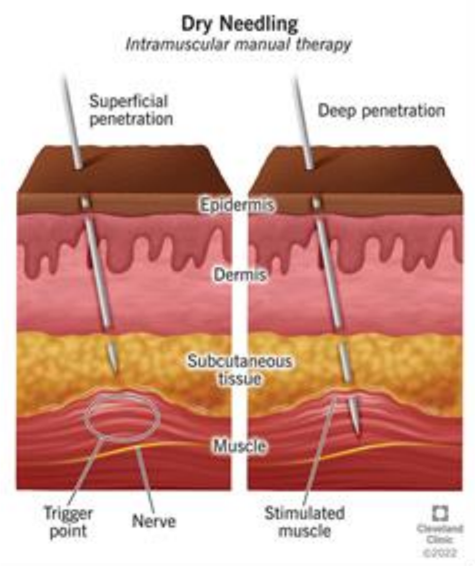
Contraindication. MET with post-isometric relaxation is contraindicated in patients with an acute fracture or dislocation. Those with tissue damage to ligaments, tendons, and muscles may not be the best candidates. It is best to wait for vital stability before trying this technique. If muscle spasm is centrally mediated, patients will also not respond well to MET. Patients need to be cooperative to follow the instructions required for this technique.

Dry Needling

Dry needling is a therapeutic technique where healthcare practitioners use (where allowed by state law) to treat pain and movement impairments. The practitioner inserts a "dry" needle, one without medication or injection, into areas of the muscle.

Dry needling involves a thin filiform needle. The needle penetrates the skin and stimulates underlying myofascial trigger points and muscular and connective tissues. The needle allows the therapist to target tissues they are not able to reach with their hands.

Figure 11. Dry Needling



The Science Behind Dry Needling:

- Trigger point reduction – Trigger points are hyper-irritable spots within a muscle that are associated with the formation of taut muscle bands and the development of pain. By inserting a needle into these points, dry needling can disrupt the dysfunctional muscle fibers, causing them to relax, reducing pain and discomfort.
- Improved blood flow: The insertion of needles into the affected muscles can stimulate blood flow to the area. Improved circulation can help bring necessary nutrients and oxygen to the muscle tissues, promoting healing and reducing inflammation.
- Release of neurotransmitters: The act of needling is believed to stimulate the release of endorphins and other neurotransmitters, which have pain-relieving effects.

Types of Dry Needling

Trigger Point. Trigger point dry needling is just what it sounds like; when your patient's pain stems from an active trigger point, you can use a needle to directly address that single spot until it releases (Gattie et al, 2017). If your patient's pain generator is an active trigger point, trigger point dry needling would be a very effective method of dry needling.

- Risk: Medium – If a trigger point is not the pain generator, this type of dry needling will not be effective, and you'll need to choose another method.
- Needle Length: Depends on the depth of muscle that is being treated, the size of the patient and any anatomical risk factors in the area being treated. Could range anywhere from 25 mm to 125 mm.
- Example Use Case: If a patient's myofascial pain in his or her neck is caused by a trigger point in the upper trapezius, trigger point dry needling can relieve these pain symptoms.

Superficial. Superficial dry needling (Baldry 2002; Griswold, 2019) is commonly used by many hands-on healthcare professionals. The needle is only inserted a few millimeters into the skin, reaching the epidermal layer but avoiding the muscle or bone. This method of needling targets the sensorimotor system: the needle changes the sensory input, therefore changing the motor output. Pain can be significantly altered as well.

- Risk: Low – Because the needle is not penetrating many layers of the body, there is a significantly lower opportunity to cause damage to vital organs or neurovascular structures.
- Needle Length: Typically, a short needle, only a few millimeters in length is needed. Ranges are typically from .3mm to 10mm.

- Example Use Case: In precarious areas like the thoracic spine, for example, clinicians run the risk of high risk of puncturing a lung if the needle is inserted too deeply. Superficial dry needling is a great way to change or alter this patient's pain perception while avoiding the potential of injury.

Deep. Deep dry needling (Ceccherelli et al 2002; Boluk 2016; Fernández-Carnero et al 2017) is a higher-skilled method of needling that targets the muscle directly. In some areas of the body, manually manipulating a particular muscle can be challenging depending on the location of the target muscle and the tissues that are surrounding the target muscle. Deep dry needling allows clinicians to get into the target muscle to create a change in pain perception, impact scar tissue or relax/ decrease tightness.

- Risk: High – Just like exercise therapy, laser, ultrasound and other interventions, deep dry needling can be dangerous if you aren't incredibly knowledgeable about human anatomy. Only attempt this type of needling if you're experienced and have a great respect and understanding of the surrounding anatomy .
- Needle Length: 15mm-125mm (depending on the target structure)
- Example Use Case: If a patient's piriformis muscle is incredibly tight and causing sciatic nerve pain, deep dry needling can be used to get past the glute muscles and tissue and decrease piriformis tightness, therefore decreasing sciatic pain.

Periosteal Pecking. Periosteal pecking involves using a dry needle to actually peck at the bone in an attempt to help with healing (Dunning et al, 2018). This triggers neuroendocrine responses which, when done intracapsularly, can help those dealing with painful osteoarthritis symptoms. Hyaluronic acid production, anti-inflammatory processes and increases in endogenous opioid levels are other reasons why we think periosteal pecking is effective, specifically in knee osteoarthritis.

- Risk: High – Inserting a needle into the joint capsule carries risk. Surgical implants and infection risk factors need to be considered for each patient.
- Needle Length: Deep enough to get close to or down to the bone. Length will vary based on the size of the patient and area being needled.
- Example Use Case: If a patient with knee osteoarthritis is experiencing pain, use periosteal pecking, with or without electrical stimulation, in and around the knee joint in order to alter pain perception in the area and help stimulate chemical reactions that can help kickstart the healing process.

Electrical Stimulation. Adding electrical stimulation to the needles is a specialized form of dry needling. The addition of electrical stimulation triggers a neuroendocrine response that is different than needles alone (Butts and Dunning 2016, Perreault et al 2018). This form of dry needling taps into different pain modulation centers and pathways in the central nervous system, making it a possible choice for chronic pain patients and patients with osteoarthritis.

- Risk: Moderate – Certain conditions are contraindicated to using electrical stimulation, such as patients with pacemakers. The associated risk of other systemic issues must be taken into account on an individual basis.
- Needle Length: Deep – There is not enough purchase of the epidermis with superficial needling to attach electrical stimulation, so the needle must be in the muscle at least, or even down to the bone if using the electrical stimulation to carry out periosteal pecking.
- Example Use Case: See Periosteal Pecking above.

Peripheral Neuromodulation. Peripheral neuromodulation is beyond the scope of practice for most orthopedic healthcare professionals and should only be performed by a licensed acupuncturist or a western medical practitioner with internal medicine education (Longhurst and Tjen-A-Looi, 2013). This complicated and dynamic form of needling is used to affect organs, but the mechanism behind this concept can be activated any time you insert a needle. We do not get to choose what is being affected when a needle is inserted into a patient; the body will do with the stimulus what it will, meaning a systemic reaction is always a possibility when needling, even if it is not the desired result.

It's no secret that organ pain can cause somatic pain – chest pain comes standard with a heart attack, and back pain is common with kidney stones. However, this is not a one-way street. The connection also goes the opposite way, which means that it is possible to use a needle within the somatic system to address organ issues or systemic issues.

- Risk: High – While you can use needles to affect certain change, ultimately the nervous system chooses what's going to be affected. This increases the risk for autonomic nervous system reactions, such as changes in blood pressure or heart rate.
- Needle Length: Variable, depending on the structure being targeted.
- Example Use Case: When acupuncturists are treating conditions like asthma, high blood pressure, or anxiety, peripheral neuromodulation concepts are used.

Dry Needling Side Effects. Many patients do not experience any side effects following a dry needling session. Dry needling is generally considered safe when performed by trained certified license health practitioner The below risks are rare. However, there are some considerations and potential risks to keep in mind.

When side effects do occur, they are most often mild. Dry needling side effects include:

Temporary Increase in Pain. This usually occurs with 24 to 48 hours following treatment and may resolve on its own or with gentle activity or stretching of the area or light massage.

Bruising or Bleeding. Bruising or bleeding can occur at the insertion site. Bleeding or bruising at the insertion point is rare and only affects about 10% of patients. If you are on blood thinners or have blood vessel problems, you may be more likely to experience this side effect.

Fainting. Fainting is another uncommon risk that is most likely to affect healthy, athletic men, older or weaker individuals, middle-aged women with blood pressure under 120/70 and people who are dehydrated, hungry or eat immediately before their appointment.

Fatigue and Tiredness. Some people can experience general feelings of fatigue or weakness.

Skin Reactions. Small red spots may develop on your skin as a histamine reaction to the needles. These spots usually go away on their own within a few minutes or a few hours.

Pneumothorax. Pneumothorax, or a collapsed lung, is an extremely rare side effect that can generally be avoided by only seeking dry needling services from people with the proper training and certification

The effectiveness of dry needling can vary among individuals, and not everyone experiences immediate relief.

Absolute Contraindications. Dry needling (DN) therapy should be avoided in patients under the following circumstances

- Unwilling or unable to give consent due to fear, believes, communication, cognitive, age-related factors.

- Medical emergency or acute medical condition.
- Local infection
- Over an area or limb with lymphedema as this may increase the risk of infection/cellulitis and the difficulty of fighting the infection if one should occur.
- Inappropriate for any other reason.

Relative Contraindications.

- Abnormal bleeding tendency
- Compromised immune system
- Vascular disease
- Diabetes
- Pregnancy
- Children
- Frail patients
- Patients with epilepsy
- Psychological status
- Patient allergies
- Patient medication
- Unsuitable patient for any reason

Patients and Methods

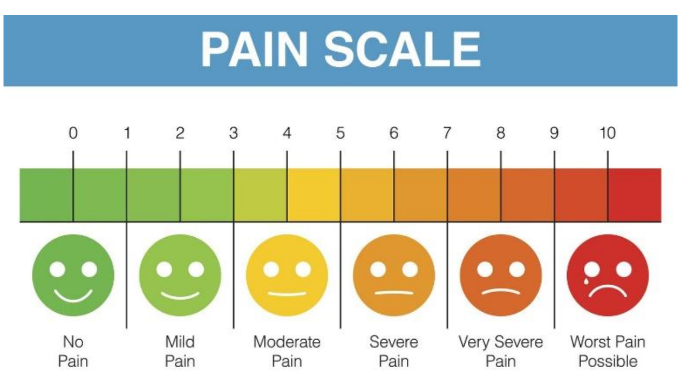
Participants

A total of fifteen (15) patients with discomfort due to knee pain, previously diagnosed as knee osteoarthritis (OA) by a consultant orthopedic surgeon based on ACR clinical classification criteria for knee OA, met the screening criteria for inclusion in this study from the physiotherapy outpatient department (OPD) of Specialised Rehabilitation Hospital, Abu Dhabi, United Arab Emirates. The inclusion criteria used for this purpose were as follows: female (as per UAE health authority guidelines for the hospital) patients aged between 45 and 80 years; moderate to severe pain in one/both knees for three months; a pain intensity score between 6 and 8 on the numeric pain rating scale (NPRS); self-reported crepitus during knee motion; exhibited a grade between 3/5 and 3-/5 on the Manual Muscle Testing (MMT); and moderate to severe range of motion test using goniometer ranging from 5-100 to 10-90 for knee flexion and 100-5 to 90-10 for extension. Note that patients screened may or may not be taking pharmacological intervention such as anti-inflammatory medication, analgesics and calcium supplements prior to the intervention. However, the patients were advised not to take any of the prescribed medications once procedures had commenced.

Outcome Measures

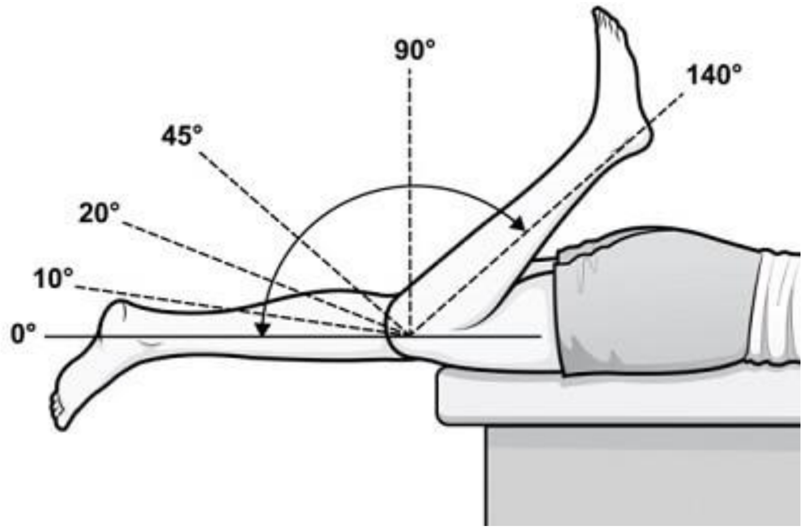
This study analysed the outcomes from the pain intensity (using Visual Analogue Scale (VAS) measure) and range of motion testing using goniometer, and muscle strength using MMT procedure. The VAS is a 10-point scale, beginning at 0 and ending at 10 (see Figure 12) and is one of the measures used in clinical settings to assess pain intensity.

Figure 12. VAS Scale Used in the Study



For the range of motion, the universal goniometer used was a full goniometer (360°) with one-axis joints with two-arms (one movable and one fixed arm), the typical knee range of motion is provided in Figure 13.

Figure 13. Typical Knee Range of Motion (Maximum)



Source: https://www.knee-pain-explained.com/knee-range-of-motion.html

For the measurement of muscle strength, the standard MMT procedure was used (Figure 14).

Figure 14. MMT Muscle Strength Grade Scale

MANUAL MUSCLE TESTING PROCEDURES

Key to Muscle Grading

	Function of the Muscle	Grade		
No Movement	No contractions felt in the muscle	0	0	Zero
	Tendon becomes prominent or feeble contraction felt in the muscle, but no visible movement of the part	T	1	Trace
Test Movement	**MOVEMENT IN HORIZONTAL PLANE**			
	Moves through partial range of motion	1	2-	Poor-
	Moves through complete range of motion	2	2	Poor
	ANTIGRAVITY POSITION			
	Moves through partial range of motion	3	2+	
Test Position	Gradual release from test position	4	3-	Fair-
	Holds test position (no added pressure)	5	3	Fair
	Holds test position against slight pressure	6	3+	Fair+
	Holds test position against slight to moderate pressure	7	4-	Good-
	Holds test position against moderate pressure	8	4	Good
	Holds test position against moderate to strong pressure	9	4+	Good+
	Holds test position against strong pressure	10	5	Normal

Modified from 1993 Florence P. Kendall. Author grants permission to reproduce this chart

Procedures

This study is comparative in nature and the sample used was a sample of convenience, in which all the knee OA patients were referred by an orthopedic surgeon to the physiotherapy outpatient department (O.P.D) of our hospital and subsequently recruited for this study.

The interventions for the patients in this study included the following:

- Ostepathic techniques:
    - Muscle Energy Technique on knee joint
    - Joint mobilization on knee joint
- Dry needling.

Results and Discussion

The study aimed to evaluate the effectiveness of osteopathic techniques in combination with dry needling procedures as interventions in patients with knee OA. The following sections present the results of the initial treatments of the subject patients.

Pre-treatment Measurements

Data from the 15 patients given the prescribed interventions for this study showed baselines of moderate to severe scores as shown in Table 1.

Table 1. Baseline Measurements

Age	No. of Patients	Pain Score (VAS)	MMT Measure	ROM Knee Flexion	ROM Knee Extension
45-55	4	6/10	3/5	5-100	100-5
56-65	5	7/10	3/5	10-95	95-10
66-80	6	8/10	3-/5	10-90	90-100

Notes: Initial assessment prior to intervention treatment

Post-treatment Measurements

Among 15 subjects, the outcomes of the of the key measurement indicators show marked improvements from the baseline measures, particularly for the pain scores and the knee range of motion as shown in Table 2.

Table 2. Post-treatment Measurements (1st session)

Age	No. of Patients	Pain Score (VAS)	MMT Measure	ROM Knee Flexion	ROM Knee Extension
45-55	4	4/10	3/5	4-105	105-4
56-65	5	6/10	3/5	8-97	97-8
66-80	6	7/10	3-/5	9-92	92-9

Notes: Immediate results after the 1st session

Based on the prior measurements of pain indicators, muscle strength and range of motions, there appears to be some minor improvements on the baseline measurements (Table 3).

Table 3. Post-treatment Measurements (Prior to second session)

Age	No. of Patients	Pain Score (VAS)	MMT Measure	ROM Knee Flexion	ROM Knee Extension
45-55	4	4/10	3+/5	4-110	110-4
56-65	5	5/10	3+/5	7-100	100-7
66-80	6	7/10	3/5	9-98	98-9

Notes: Assessment prior to second treatment session after 3 days

Immediately after the second session, further improvements on the measurements on pain, muscle strength and range of motion of the knees of the patients were observed (Table 4).

Table 4. Post-treatment Measurements (After second session)

Age	No. of Patients	Pain Score (VAS)	MMT Measure	ROM Knee Flexion	ROM Knee Extension
45-55	4	4/10	3+/5	4-110	110-4
56-65	5	5/10	3+/5	7-100	100-7
66-80	6	7/10	3/5	9-98	98-9

Notes: Assessment after completion of second session

Based on the above assessment, the patients have mostly shown improved measurements upon receiving the prescribed interventions of osteopathic and dry needling treatments. As expected, the younger patients have shown more improvements as compared to older patients.

This study was limited due to the availability of the intervention procedures considering that patients were only allowed a maximum of 6 sessions as per medical insurance provider guidelines. Therefore, any retention effects that is often observed in longer-term and follow-up sessions cannot be fully ascertained at this stage.

Conclusion

Knee pain can be debilitating and affects individuals of all ages and activity levels. Whether you're an athlete recovering from injury, a fitness enthusiast dealing with general knee discomfort, or someone simply trying to manage the aches and pains of everyday life, finding effective solutions for knee pain is vital to live a full life.

Studies are now showing sufficient evidence with dry needling involving periosteal bone stimulation for a variety of arthritic conditions. The thought process behind periosteal stimulation is to stimulate healthy blood flow to promote a natural healing response to the degenerative tissue by stimulating osteoblastic production. In dry needling with periosteal stimulation, both electrical dry needling and periosteal bone tapping has been shown to be advantageous. Specifically, these studies have been shown to reduce T2 signal on MRI, stimulate hyaluronic acid production, reduce interleukin-6 mRNA expression in bone marrow, and decrease plasma cortisol levels. Multiple studies support the use of periosteal bone stimulation with dry needling for mild to moderate knee osteoarthritis. Given that the knee osteoarthritis is one of the causes of myofascial pain syndrome, the probability of trigger points formation is higher in muscles playing a role in the knee joint loading and stabilization compared to others. Head of gastrocnemius and quadricep muscle (primarily vastus medialis oblique), these muscles affected by myofascial pain syndrome, while myofascial trigger points are the main cause of pain in this syndrome. It requires emphasizing that trigger points (TrPs) as one of the most common sources of musculoskeletal pain, are an undeniable element in patients with knee or osteoarthritis and may cause some symptoms such as pain, loss of range of motion, and joint stiffness.

Subjectively, pain levels and the patients' perceived disability were statistically improved from their dry needling treatment.

Additionally, dry needling performing muscle energy techniques on knee can give more positive results includes decreased stiffness, decreased pain, and increased range of motion. When the joints are in good alignment, the muscles are within normal tone; there is a decrease of pain. The patient is able to strengthen the weak muscles, to resume normal activities and to return to health and well-being.

Overall, the combination of osteopathic techniques MET and non-invasive dry needling for knee osteoarthritis should be considered as an additional treatment for knee osteoarthritis patient.

References

Al-Omari, B., Farhat, J., Khan, M., Grancharov, H., Zahr, Z. A., Hanna, S., & Alrahoomi, A. (2023). Exploring patient treatment decision making for osteoarthritis in the UAE: a cross-sectional adaptive choice-based conjoint study. *BMC Public Health*, *23*(1542), 12.

Al-Saleh, J. A., Albelooshi, A. A., Salti, A. A., Farghaly, M., Ghorab, A. M., Linga, S., . . . Joury, J. G. (2022). Burden, Treatment Patterns and Unmet Needs of Osteoarthritis in Dubai: a Retrospective Analysis of the Dubai Real-World Claims Database. *Rheumatology and Therapy, 9*, 151-174.

Institute for Health Metrics and Evaluation (IHME). (2024, 05 31). *GBD Results*. (Seattle, WA : IHME, University of Washington) Retrieved 05 31, 2024, from Institute for Health Metrics and Evaluation, Data Tools and practices, Interactive data visuals: https://vizhub.healthdata.org/gbd-results/(link is external)

Nejati, P., Farzinmehr, A., & Moradi-Lakeh, M. (2015). The effect of exercise therapy on knee osteoarthritis: a randomized clinical trial. *Medical Journal of the Islamic Republic of Iran (MJIRI)*.

Salih, S. S., Alsalihi, R. M., Mahboub, N. E., Jasim, N. Y., & Almutawa, R. A. (2024). Assessment of Public Knowledge and Awareness of Knee Osteoarthritis Among Individuals Aged 18-65 in the United Arab Emirates (UAE). *Cureus, 16*(1), 9.

Sen, R., & Hurley, J. A. (2023, 02 20). *Osteoarthritis.* Retrieved 05 31, 2024, from StatPearls: https://www.ncbi.nlm.nih.gov/books/NBK482326/

Thysen, S., Luyten, F. P., & Lories, R. J. (2015). Review: Targets, models and challenges in osteoarthritis research. *Disease Models & Mechanisms, 8*, 17-30.

Vitaloni, M., Bemden, A. B.-v., Sciortino, R., Carné, X., Quintero, M., Santos-Moreno, P., . . . Möller, I. (2020). A patients' view of OA: the Global Osteoarthritis Patient Perception Survey (GOAPPS), a pilot study. *BMC Musculoskeletal Disorders, 21*(727). Retrieved from https://doi.org/10.1186/s12891-020-03741-0

https://www.joionline.net/

Teachanatomy.info

Orthiinfo.aaos.org

Osteopathy.org.uk

O-c-o-ca/techniques.php

O'Sulivan's Physical Reahabilitation 6th edition

Uco.ac.uk/about-osteopathy

Choosept.com/health-tips/dryneedling Kinetikchaindenver.com

My.clevelandclinic.org/health/treatments/1652dry-needling

Muscle Energy Technique – Physiopedia

Dry Needling Options for Knee Osteoarthritis – Central Nebraska Rehab Services

Effects of Dry Needling on Pain in Patients with Knee Osteoarthritis: A Preliminary Study – PMC

Physiology, Muscle Energy – StatPearls – NCBI Bookshelf

6 Types of Dry Needling and How to Choose the Right One

Gattie et al, 2017 Longhurst and Tjen-A-Looi, 2013 Butts and Dunning 2016, Perreault et al 2018 (Dunning et al, 2018) Ceccherelli et al 2002; Boluk 2016; Fernández-Carnero et al 2017) (Baldry 2002; Griswold, 2019) https://denverphysicalmedicine.com/blog/dry-needling-side-effects/

https://www.physicaltherapyannarbor.com/physical-therapy-treatments/muscle-energy-technique