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Updated review on overview of dry needling

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***Abstract*---**Dry needling is a therapeutic method that involves inserting a filiform needle into a target area. Osteoarthritis is a degenerative joint disease that affects the articular cartilage, causes discomfort, and changes the biomechanics. Ling is a component of conservative or comprehensive physiotherapeutic management. Increased blood flow, metabolic changes, spontaneous electrical activity, pain gating, and other mechanisms of action of dry needling may generate therapeutic advantages in osteoarthritis. The history of dry needling is extensively discussed. Needling can be defined as superficial or deep needling depending on the depth of the needle insertion, and it can also be classified as trigger point dry needling, fascial needling, scar tissue needling, and so on. The mechanism of Dry Needling is explained by a variety of ideas. The local effects of dry needling were also explored in this review, as well as the mechanism of analgesic effects. The needles can be utilized to provide therapeutic current to the tissues in a variety of ways. It can be done with PENS (Percutaneous Electrical Nerve Stimulation) or ETOIMS (Electro Transcutaneous Electrical Nerve Stimulation) (Electrical Twitch Obtaining Intramuscular Stimulation). This review effectively brought numerous features of dry needling to light while also discussing the current therapeutic state of dry needling.

***Keywords*---**dry needling, osteoarthritis, pain, needling, pens.

Introduction

Dry needling is the procedure of insertion of filiform needle into the target tissue for therapeutic benefit. The potential benefits of dry needling include deactivation of trigger point, reduction of pain, promotion of healing, and alterations in the neuro-myo-fascial continuum. Although osteoarthritis is a degenerative joint disease that primarily affects the articular cartilage, pain and altered biomechanics in osteoarthritis also affects other contractile and non-contractile

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soft tissues. Mild to moderate osteoarthritis is treated conservatively, which includes analgesics, exercises, lifestyle modifications, and physiotherapeutic interventions directed to articular and soft tissues (Dunning et al., 2014; Calvo-Lobo et al., 2018).

In recent times there has been an increase in the use of dry needling is the part of comprehensive physiotherapeutic or conservative management. There are several mechanisms of action of dry needling including increased blood flow, biochemical changes, spontaneous electrical activity, pain gate etc which may produce therapeutic benefits in osteoarthritis. Figure 1 shows a typical scene of dry needling (Butts et al., 2021).

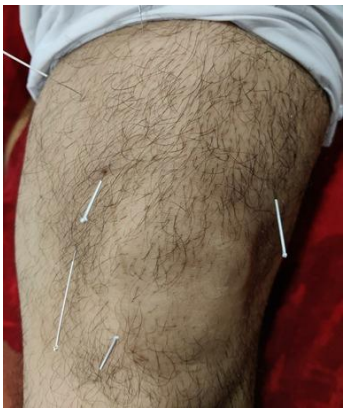

Figure 1: Typical scene of dry needling

History of dry needling

The idea of dry needling emerged from the usage of injectable anesthetic for treatment of musculoskeletal pain. In 1930s, Kellgren suggested the concept of tenderness and illustrated the pattern of pain referral from specific muscles. In 1942, Janet Travell et al. (1942) used the term "trigger points" to describe tender points and brough the concept of myofascial trigger points. Again in 1941, Brav and Sigmond put forwarded that pain can be relieved by simple technique of needling without injecting any chemical substance. This was the first time a published paper brought dry needling to attention. However Brave and Sigmond referred Churchill's published paper dated back to 1821 which mentioned the injection treatment of sciatica and lower back pain. In 1979, Lewit suggested that the conventional drug injection therapy comprise of 2 independent parts: the role played by the injected drug and the effect of needling (Lewit K., 1979). Soon after this number of researches on the effect of needling saw an upsurge. This method was named “dry needling” to discriminate it from the customary drug injection, commonly referred as “wet needling”. Since then Dry Needling has been extensively used in therapeutic purpose, specially tendon lesions and pain caused by joint replacement surgery (Mayoral O., et al, 2013). Figure 2 gives a summary of evolution of dry needling.

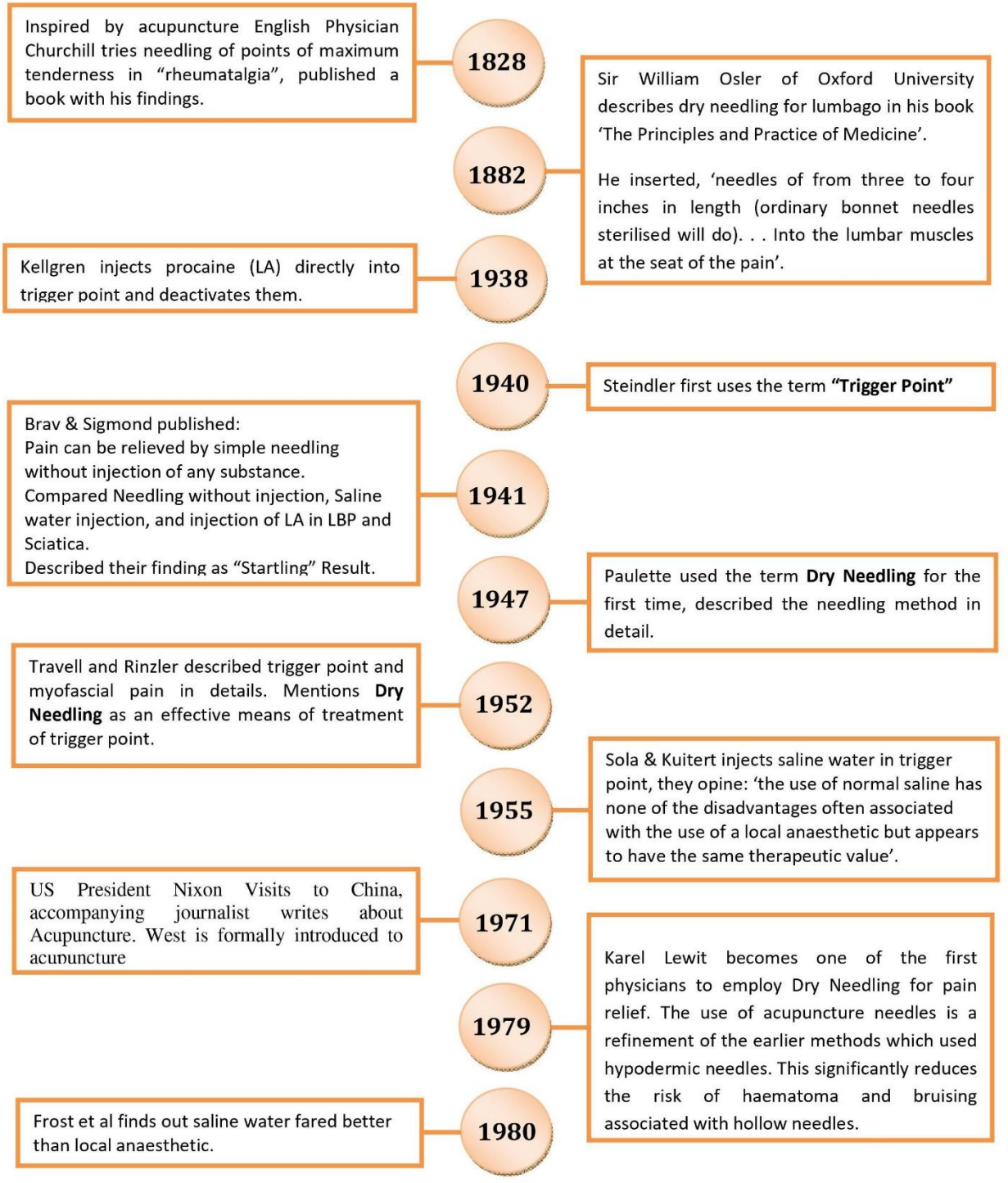

Figure 2: Evolution of dry needling

Types of dry needling

Dry Needling can be classified in various ways. Based on the depth of the needle insertion, needling can be termed as superficial and deep needling, based on the structure that is being needled it can be classified as trigger point dry needling, fascial needling, scar tissue needling etc. The classifications are almost always overlapping. Listed below are a few popular types of needling. In *Trigger-point Dry Needling,* MTrPs are localized hypersensitive spots in a palpable taut band of muscle. (Gattie E., et al, 2017). Trigger points can be diagnosed by a cluster of three diagnostic criteria: a taut band, a hypersensitive spot, and referred pain. (Fernandez C, Dommerholt J. International Consensus on Diagnostic Criteria and Clinical Considerations of Myofascial Trigger Points: A Delphi Study. Pain Medicine 2018; 19: 142–150). In MTrP DN needles are inserted directly into the trigger point to mechanically disrupt it. Often a small twitch is felt/seen during the procedure, known as local twitch response (LTR). While traditionally an LTR was an essential component of DN, evidences suggest that needling is as effective without LTR (Perreault et al., 2017). In *Superficial Dry Needling* the dry needles are inserted 5-10 mm deep into the skin without going into the target tissue. Peter Baldry was the proponent of Superficial Dry Needling (SDN) and he argues that because the pain of MTrP is primarily because of hypersensitivity of nociception, it can be modulated by A delta stimulation, which is possible through insertion of needle through a short distance. (Griswold, D., et al, 2019; Baldry P., 2002). Because SDN does not go deep into the tissues it is a much safer alternative (Griswold, D., et al, 2019). In *Deep Dry Needling* (DDN) a longer needle is used to reach the target tissue and it is often manipulated upon insertion (Ceccherelli F., et al, 2002; Fernández-Carnero, Josué., et al, 2017). DDN in a lot of ways are similar to MTrP DN. However, DDN can be employed in tissues other than muscles. There have been evidences of effectiveness of DDN in patients having problems in spine and the pain is unbearable and intense (Boluk and Huma., 2016). *Intramuscular Stimulation* was developed by Chan Gunn around 1970's. Instead of regarding pain to be signals of tissue injury, IMS views pain because of nerve pathology. Compression of nerve via soft tissue, which Gunn calls 'radiculopathy model' is the cornerstone of this needling style. (C Chan Gunn, 2002). Another type of dry needling started by Dr Yun Tao Ma, *Integrative Dry Needling*, this school of dry needling involves needling of the nerves and reflex points (Ma, 2011). Dry Needling for Hypertonicity and Spasticity: DNHS® has been proposed by Pablo Herrero who describes the use of dry needling to create therapeutic benefits in neural as well as mechanical aspects of the neuromuscular continuum. This type of needling is used specifically in hypertonicity and spasticity. Other less popular needling schools include spinal segmental sensitization, Fu's subcutaneous needling etc (Gallego & del Moral, 2007).

Mechanism of dry needling

There are many theories (Zylstra, E., & Maywhort, K.R. 2017) that explain the mechanism of Dry Needling. Some of the most accepted ones are:

- Enhanced blood flow- it is said that 'needling of the trapezius and Achilles tendon' accelerates flow of blood at the localized, needled site.

- Subsided banding- it has been perceived that after undergoing Dry Needling banding of the target tissue gets dwindled and occurs restitution of 'sarcomere length and endomysium spacing'.
- Ebbed spontaneous electrical activity- stimulation of 'local twitch response of a trigger point' tapers electrical activity at that site which may show up as normalancy getting restored at neuromuscular junction.
- Biochemical changes- After Dry Needling therapy (of an Active TP) there is seen a local suppression of high concentrations of H^+ ions, ' neurotransmitters (bradykinin, 5HT, NE, CGRP, and substance P), cytokines, and chemokines (TNF-α, IL-1b, IL-6, and IL-8)'.
- Pain gate- the thought has also been proposed that action of needle insertion may bring about 'sensory and proprioceptive stimuli' which may impact the 'gate control mechanisms' of diminishing of pain.

The summary of the above explained theories are given below (Figure 3)

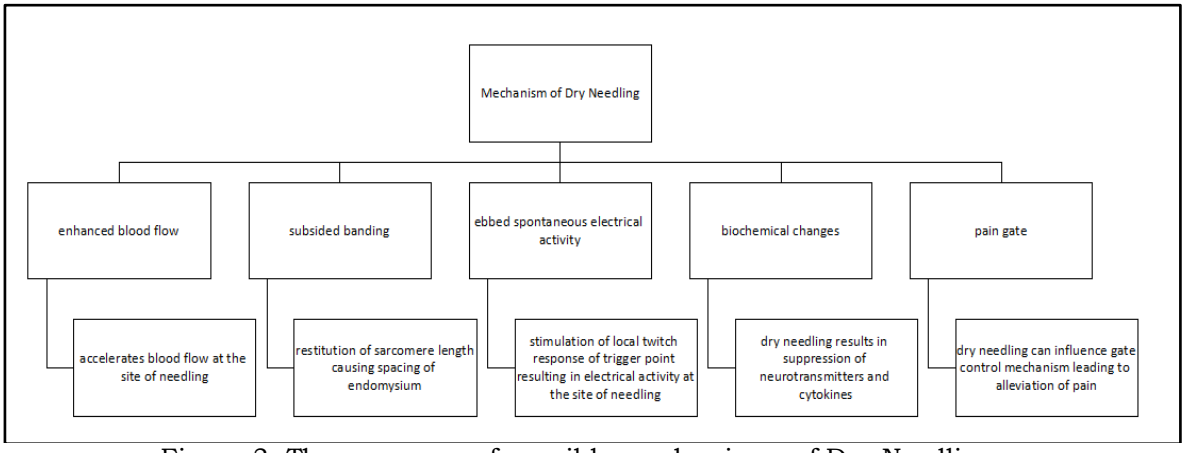

Figure 3: The summary of possible mechanisms of Dry Needling

Local effects of dry needling

Injury from needling produces rapid local vasodilatation and increased capillary permeability (Nakazato et al., 2021) which helps in healing and analgesia. Injury potentials are generated and can persist and provide stimulation for days until the miniature wound heals. This stimulation produces synthesis of prostaglandins which increase vascular permeability. Mast cell damage causes the release of histamine and heparin causing vasodilatation. Pain is relieved as a result of improved perfusion and relief of muscle spasm causes by local effects of needling and somatoviseral reflexes (Langevin et al., 2006).

The local effects also include increased local cortisol levels which have catabolic effect on connective tissue stimulating tissue remodeling and scar tissue breakdown. (Shah et al., 2005). The needle, once inserted, can be manipulated by rotation and pistoning. Needle manipulation causes pulling of collagen fibers towards the needle and initiates specific changes in fibroblasts. The fibroblasts respond by changing shape. The transduction of the mechanical signal into

fibroblasts can lead to a wide variety of cellular and extracellular events leading to neuromodulation and healing (Langevin et al., 2006).

Analgesic effects

The analgesic effect of dry needling involves multiple mechanisms including immune, hormonal, and nervous systems. The stimulation of Aδ blocks the pain transmission of slow C fiber, this effect may persist for hours after needling due to the injury potential Stimulation of the sensory afferent Aδ also activates enkephalinergic, serotonergic, and noradrenergic inhibitory systems. A delta primary afferent receptors project to marginal cells (M) which carries pinprick sensations in the lateral spinothalamic tract. At the same time the A delta primary afferent receptors project to enkephalinergic stalked cells (ST) in the spinal cord, which inhibit the cells of substantia gelatinosa of Rolando (SGR) and block the transmission of C pain. This is known as segmental modulation. The seretonergic system involves midbrain and medulla. The fast pain carrying fibers of lateral spinothalamic tract give collaterals to peri aqueductal gray matter (PAG) of mid brain. PAG in turn activates Nucleus Raphe Magnus (NRM) of medulla which stimulates ST cells and inhibits SGR (Bowsher D, 1998; Cheng, 2014).

The noradrenergic system involves medulla and pons. The nucleus paragigantocellularis (PGC) of medulla influences locus coeruleus (LC) of pons or similar noradrenergic brainstem structures which controls firing of SGR and modulates pain. Also active are the Diffused noxious inhibitory control where direct input of A delta generated information to Reticularis Dorsalis (R) in medulla inhibits pain by its influence on spinal segment. Together all these systems of pain modulation are known as Opioid Mediated Analgesia System (OMAS) (Kitahata L. M. (1993; Al-Chaer, 2009).

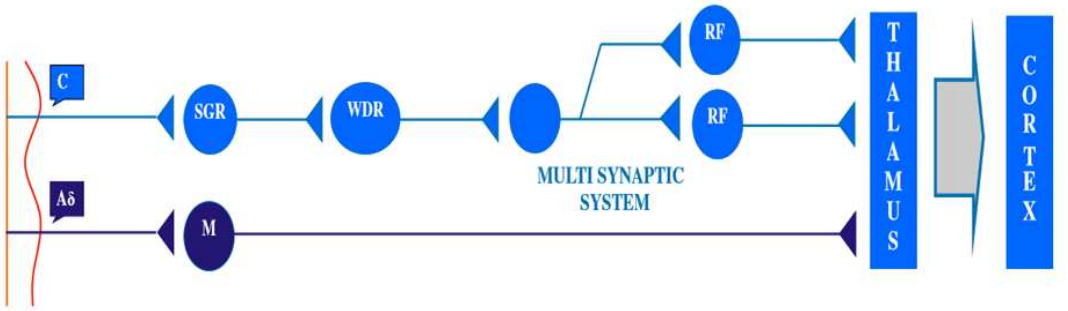

Figure 4: The pain pathway, C and Aδ, and its conduction route are depicted, from receptor to thalamus via 2nd order neuron, finally reaching cortex through 3rd order neuron

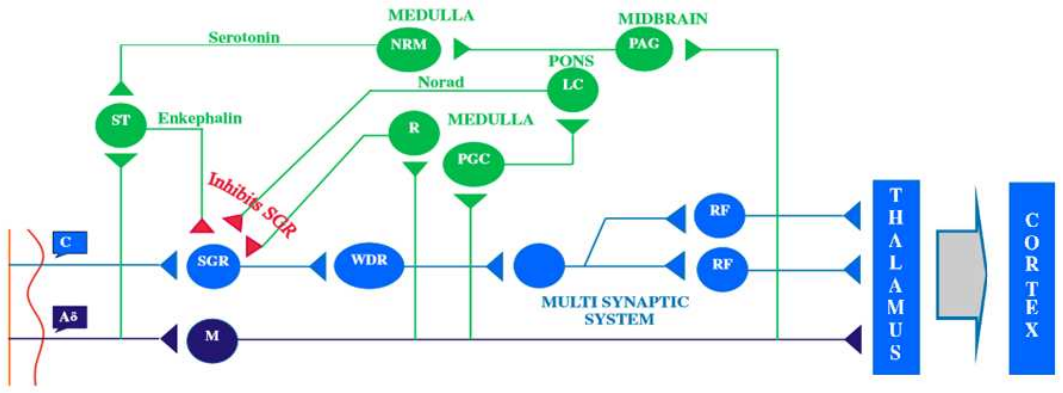

Figure 5: The Pain Pathway and its regulation

Trigger point and dry needling

According to Travell and Simons (Vas J., et al, 2004; Scharf HP., et al, 2006), a trigger point (TP) can be defined as a 'hyper-irritable spot in a taut band of skeletal muscle or the fascia which is under pain when compression happens to it and the peculiar pain thus produced, is called as 'tenderness, motor dysfunction, and/or autonomic phenomena'. A trigger point is teremed 'active trigger point' when there is spontaneous pain. In contrast to it, a 'latent trigger point' qualifies on all elements mentioned above without the production of peculiar pain

Electromyographically a trigger point is a source of spontaneous electrical activity (SEA) coming from a dysfunctional motor end plate which experience a thousand fold increase in the acetyl choline level (Gerwin, 1999). TPs generally are known to exist in an acidic environment. Inserting needles into the trigger point creates a small contraction, called Local Twitch Reflex (LTR). The LTR is hypothesized to change in local environment, creating an increased pain threshold and thus reducing pain (Shah, 2021).

The twitch also results in stimulation of neural fibers (C and Ad). This, in turn, affects spinal cord bringing further inhibition to nociception and heterosynaptic inhibition (Zylstra, E., & Maywhort, K.R. 2017). The mechanism is schmatically presented below (Figure 6).

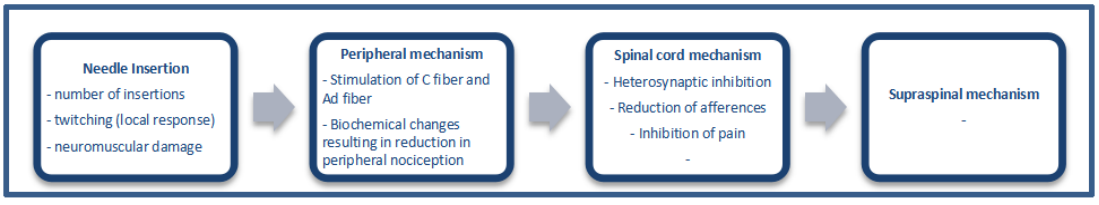

Figure 6: The summary of the mechanism of dry needling

Process of dry needling

The needling process involves insertion, manipulation and withdrawal of the needling. Most often the insertion is done using a guide tube, which is a hard plastic tube through which the needle is tapped. The use of guide tube minimizes pain. The needles come in various sizes, both in diameter and length. The choice of needle length depends on the depth of the target tissue, which means for superficial dry needling a smaller (usually 13 mm needle) is used whereas a deep seated structure (e.g. piriformis) will need a much larger needle. The angle of insertion also has important implications. The needle should be angled towards the target tissue and away from a vulnerable tissue. Also, needling of superficial structures (superficial fascia/scar in the skin) needs more acute angle (eg 15 degree angle) (Dommerholt J., 2011).

Needle manipulation

Once inserted the needle can be manipulated for therapeutic purposes. Although chinese acupuncture has a wide variety of manipulation techniques, however, in case of dry needling, the manipulations can be summarized into 4 broad categories. 4 types of needle manipulations are:

- Pistoning: Pistoning is described as rapid movement of the needle in and out of the MTrP (Cerezo-Téllez and Ester et al., 2016).
- Fanning/Fishing: A variation of pistoning, this technique uses the inclination angle of the needle along with up and down movement. Rossi advocates manipulating the needle for at least 30 seconds with 1hz frequency (Rossi and Ainsley et al., 2017). Fanning has been claimed to increase the chances of locating the loci of trigger point and eliciting twitch response (Rowley N.C, 2001).
- Needle rotation: Once the needle is inserted through the skin to the target tissue, the needle can be rotated clockwise and anticlockwise. It has been found that needle manipulation produces winding and gathering of collagen around the needle. Within minutes of needle rotation pulling of collagen toward the needle induces an active cellular response in connective tissue fibroblasts up to several centimeters away from the needle (Dunning J. et al., 2014).
- This transduction of the mechanical signal into fibroblasts can lead to a wide variety of cellular and extracellular events leading to neuromodulation and healing. (Simons *et al* 2002)
- Pecking/ Peppering: In case of chronic inflammatory condition especially in the junction of periosteum and ligament/tendon, to accelerate the healing response an acute inflammation is created by 'Pecking' that is, tapping the needle on the bony area multiple times after insertion. The resulting acute inflammation brings forth healing (Taşoğlu et al., 2017).

Fishing

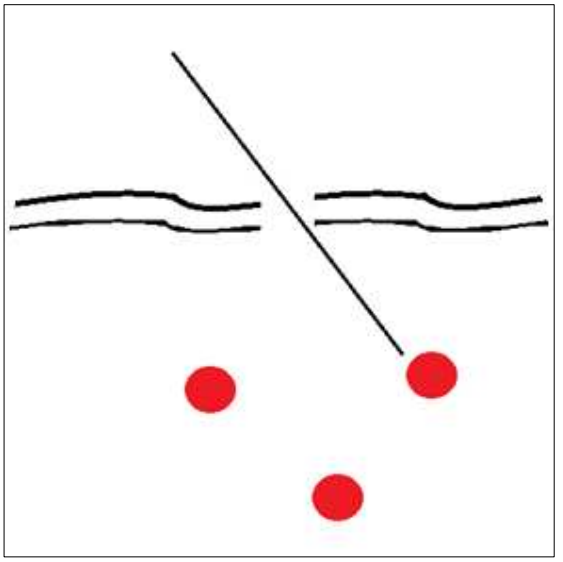

Figure 7: A typical depiction of fishing (needle manipulation)

Dry needling as a medium of current delivery

The needles inserted to the body is often used as an electrode to deliver therapeutic current to the tissues. This is usually done in two ways, first is the use of a current similar to TENS, which is termed as PENS (Percutaneous Electrical Nerve Stimulation) whereas the other one is termed as ETOIMS (Electrical Twitch Obtaining Intramuscular Stimulation). PENS is largely for pain relief. They are a biphasic continuous waveform, with frequencies either between 2-5Hz or 80-100Hz and a pulse duration ranging from 250 to 500 microseconds (Park et al., 2020; Plaza-Manzano et al., 2020). All forms of PENS are usually applied in a biphasic continuous waveform, at a low (2-5Hz) or high (80-100Hz) frequency with pulse duration ranging from 250 to 500 microseconds. It can be argued that the use of PENS involves other pain modulation pathways like Dorsal column and analgesic neurotransmitters like GABA in addition to the pathways already active from dry needling (Plaza-Manzano et al., 2020; Sayson & Hargens, 2008).

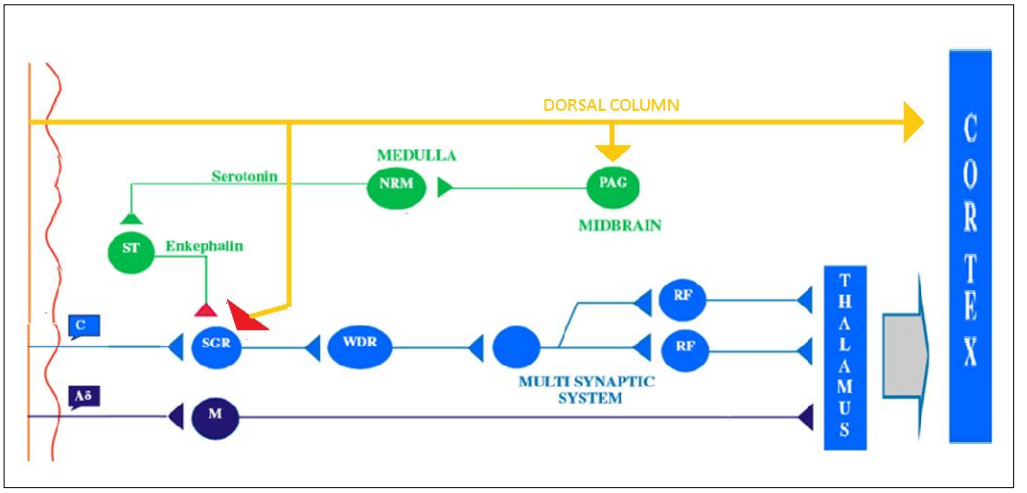

Figure 8: The action of Electrical Twitch Obtaining Intramuscular Stimulation on Pain Pathway

The ETOIMS on the other hand uses a low frequency stimulator on the needle to stimulate the needles to obtain visible contraction. ETOIMS uses a monopolar electrode to stimulate deep deep motor endplates (Annaswamy et al., 2011). It has been used successfully in chronic myofascial pain (Chu, J., 2004; Chu et al., 2017). ETOIMS also can potentially favorably affect muscle activation and performance by providing more effective activation of mechanoreceptors. The tool used for TOIMS is often the standard EMG stimulator, however specifically made needle stimulator is also available. The image below shows two such stimulators (Chu, 2004; Rainey, 2013).

Figure 9: EMG stimulators

Conclusion

This review has presented the scope of Dry needling elaborately. The potential benefits have been discussed with evidence. The beneficial effects of dry needling on mild to moderate arthritis has been discussed. The review highlighted that in recent days, the usage of dry needling in clinical practice has risen significantly,

either as single management or as a part of comprehensive physitherapeutic schedule. The author emphasised on the process of dry needling and main 4 types of the manipulations practiced. Dry needling is also used a medium of conducting electrode during PENS and ETOIMS. Several aspects of dry needling are discussed to bring updated information about dry needling and to support the increasing demand and need in practice of physiotherapy.

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