

Role of Interferential Therapy in Osteoarthritis Knee - A Narrative Review

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Abstract

Purpose: To overview literature regarding the role of interferential therapy in osteoarthritis knee and synthesize the findings of literature retrieved from searches of computerized databases and authoritative texts.

Method: The review analyses mechanism of pain in osteoarthritis, pathophysiology of acute and chronic pain, biophysics of interferential therapy and ends with the importance of dosimetry in physiotherapy.

Results: Studies show both positive and negative findings of the effects of interferential therapy in osteoarthritis knee. Further texts describe the use of various frequencies in management of osteoarthritis knee. Though the available research does not yield conclusive results regarding the use and dosimetry of IFT for knee pain, its results seen in a clinical set up cannot be neglected. There is a need of good quality of research in IFT for knee pain in Indian population.

Conclusion: It is the time to revisit electrophysical agents and to reassert their value as one of the pillars of Physiotherapy. Though recent research trend is not very favourable towards the use of electrophysical agents, appropriate agent, dosimetry and technique of application could definitely yield a satisfying response.

Keywords: interferential therapy, osteoarthritis, pain

Introduction

Osteoarthritis (OA) is a chronic degenerative joint disorder having a significant economic impact on our health system worldwide [1]. Approximately 10% of world's population are sixty years or older have symptomatic OA [2]. OA is the second most common rheumatologic problem and is the most frequent joint disease with prevalence of 22% to 39% in India affecting 2693 of every 1,00,000 females and 1770 of every 1,00,000 males [2,3]. OA knee represents a significant burden on health care provision [4]. OA leads to joint symptoms and signs which are associated with defective integrity of articular cartilage in addition to relative changes in the underlying bone and at the joint margins. Although articular cartilage is poorly innervated and defects in cartilage are not by themselves symptomatic, a clinical syndrome of symptoms which often includes pain may evolve from such defects [5]. Clinical

manifestations include pain and inflammation of joint capsule, impaired muscle stabilization, reduced range of motion and functional disability.

Pain In Osteoarthritis

Variety of pain patterns as described by patients exist in knee OA right from use related pain to rest pain and night pain and dull ache to sharp stabbing pain [6,7]. Current evidence suggests that OA joint damage predisposes to pain but that little correlation between pain severity and extent of joint damage exist [6]. One explanation given to this owes to the fact that the mediators released from either synovium or bone are important to symptoms in OA. The presence of knee pain has been shown to correlate with MRI findings of moderate to larger effusions as well as synovial thickening [6,8]. Bone marrow lesions detected on MRI are more prevalent in individuals with OA who have

knee pain than those who are symptom free [6,9]. Changes in bone marrow lesions and synovitis are associated with fluctuations in knee pain in patients with OA knee and that

pain resolution occurs more frequently when bone marrow lesions become smaller [6,10]. Acute pain classically relates to pain arising from tissue damage. It is provoked by a specific disease or injury, serves a useful biological purpose and is associated with skeletal muscle spasm and sympathetic system activation. It is self-limited. Chronic pain in contrast may be considered a disease state. It is the pain that outlasts normal time frame of healing. It may arise from psychological states, serves no biologic purpose and has no recognizable end point [11]. Chronic pain associated with OA involves dysfunction of central pain pathways [6,12]. Imbalance of serotonin and norepinephrine systems within central pain pathways have been implicated in the development and maintenance of central sensitization and associated chronic pain [13,14]. On a population level, pain intensity (via patient self-report) correlates poorly with peripheral joint damage assessed by Kellgren-Lawrence radiologic classification criteria [15]. Within individuals, however, pain severity is strongly associated with radiographic damage [16]. Taken together, these studies suggest that other mechanisms of pain that are not knee specific, like enhanced pain sensitivity due to alterations in central pain processing may play a role in the

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Figure 1: Four pole electrode placement for knee pain



Figure 2: Four pole method where electrodes placed in direction of ACL



Figure 3: Four pole electrode placement for knee pain with quadriceps stimulation

variability of pain severity across individuals.

Electrophysical Agents For Pain Relief

The Royal Chartered Society of Physiotherapy defines Physiotherapy as the four pillars of practice of massage, exercise and movement, electrotherapy and kindred methods of treatment. Somehow with evolving time, electro physical agents have been becoming extinct quoting insufficient or low level evidences available for EPAs. But the

Interferential Current Therapy

The basic principle of IFT is to utilize significant physiological effects of low frequency (≤ 250 pps) electrical stimulation of nerves without associated painful perception. The use of IFT is disproportionate to both the volume and quality of published evidence, though it is supported on an anecdotal evidence level and several reviews are indicating overall

IFT is proposed to give physiological effects in the deeper structures compared to TENS. When two medium frequency currents of slightly different frequencies are set up such that they cross each other by modulation of amplitude, a resultant low frequency is produced which is supposed to be the difference between the two medium frequencies. This resultant low frequency is called beat frequency [20]. By analogy this beat frequency can be considered as a packet full of sine waves perceived as one. A box with hundred sweets inside can be considered as one box instead of calling them hundred sweets. Hence in simple terms and in effects interference mimics low frequency stimulation.

According to Brenda Savage [22], different types of excitable tissue propagate impulses at widely different speeds. This fact combined with differing stimulus duration conclude that for each type of excitable tissue, there is an optimum frequency at which the maximum response will be elicited. Adjusting the beat frequency on IFT equipment will give its physiological effect over that particular tissue. Additionally by setting a variable beat frequency, one can stimulate more than one structure at the same time. The effect of different frequencies on various tissues is given in Table 1.

There has been another school of thought that says that IFT is nothing but applying TENS at a deeper area and that variable beat frequency can avoid nerve accommodation. It is beyond the scope of this article to rationalize these different thoughts. High TENS with frequency between 75-150 Hz is said to be stimulating $A\beta$ fibres which in turn suppresses pain mediated by $A\delta$ and C fibres. This is said to work according to Pain Gate mechanism by Melzack and Wall [23]. According to Brenda Savage [22] 90-100 Hz

Table 1: Tissues stimulated at various frequencies

FREQUENCY	TISSUE STIMULATED
0-5 Hz	Sympathetic nerves
10-150 Hz	Parasympathetic nerves
10-50 Hz	Motor nerves
90-110 Hz	Sensory nerves
130 Hz	Nociceptive system
0-10 Hz	Unstripped muscles

very fact is that patients now a days seek non-drug alternatives for pain relief and that poly-pharmacy is being increased in recent time to an alarming level. With the advent of recent traits of NSAIDs that claim to be safer over gastrointestinal tracts, these newer group of drugs are shown to be endangering cardiovascular system [17]. In past few years, the scientific evidence behind electro-physical agents is mounting. The Pedro-database contains more than 2300 RCTs with electro-physical agents and half of them have a method score of 6/10 or higher. Hence improved electro-physical agents trial design quality opens for new and more robust conclusions [18].

supportive evidence based especially for pain management [19].

There is an inverse relationship between the frequency with which an electrical current is applied and its depth of penetration. This is accountable to the ohmic and capacitive resistance offered to the current. Lower the frequency of the current more is the resistance applied to encounter and so the current gets absorbed or attenuated superficially giving its effects in the superficial tissues. The skin impedance at 50 Hz is approximately 3200 Ω compared to 40 Ω at a frequency of 400 Hz [20, 21]. This gives IFT a deeper penetration and better perception than transcutaneous electrical nerve stimulation (TENS). Hence

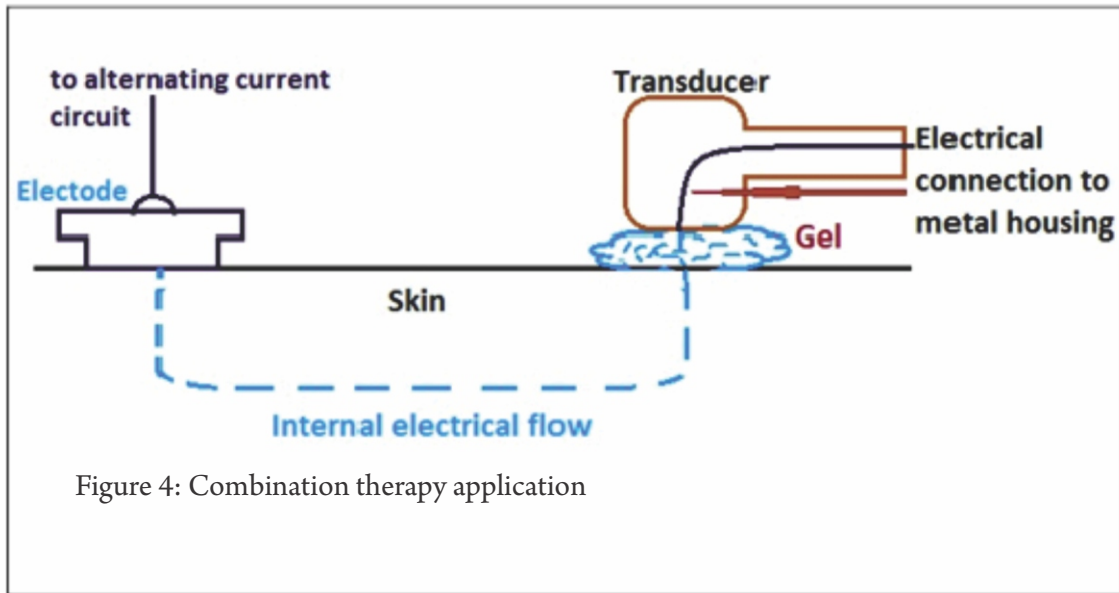


Figure 4: Combination therapy application

is optimum for sensory nerves and 130 Hz is said to affect the nociceptive system. Logically combining both these thoughts, beat frequency between 90-130 Hz as proposed by Tim Watson [21] can be an effective dosage for acute pain.

Frequency between 1-5 Hz is said to activate opioid mechanisms with release of β endorphin and enkephalin and thereby producing analgesia. According to Brenda Savage [22], 0-5 Hz is the optimum frequency for sympathetic fibres. Sympathetic nervous system is an essential trigger of intrinsic opioid analgesia within peripheral injured tissue [24]. So if both the theories are to be followed, logically these frequencies set as beat frequency can be effectively used for relief of chronic pain.

Gundog M et al demonstrated the superiority of the IFC with some advantages on pain and disability outcomes when compared with sham IFC for the management of knee osteoarthritis. It was a randomized and single-blind study on 60 patients diagnosed with knee osteoarthritis. The patients were allocated to three active IFC groups (40, 100, and 180 Hz), and one sham IFC group. However, the effectiveness of different amplitude-modulated frequencies of IFC was not superior when compared with each other [25].

Frequency of 10-25 Hz stimulates reticular formation and blocking of C fibres occurs at a frequency > 50 Hz. Hence combining all these frequencies may give an overall effect on pain as suggested by Brenda Savage. According to her 10-150 Hz stimulates autonomic nervous system resulting in

relaxation of blood vessel wall and hence an increase in blood supply is seen which in turn gives pain relief and reduction of oedema [22]. Working on muscle stimulation frequencies helps maintain muscle power and at the same time this can bring local metabolic and vascular changes and hence reduce oedema. So in all, by the use of IFT, all the structures involved in pain mechanism can be treated with appropriate use of beat frequency. In OA knee, clinically reasoning out the structural impairments and functional affection, cartilage failure leads to inflammatory changes, synovitis with effusion and pain as a result of above structural changes. Pain in turn leads to muscle inhibition, in this case of Quadriceps femoris. This vicious cycle of pain and muscle inhibition further leads to more degeneration and increased abnormal weight bearing to the knee joint. It is usually seen that as pain increases, there is a decrease in the functional ability of the patient.

Application of IFT for knee joint is primarily aimed to reduce pain. In presence of acute inflammation and joint effusion, it is absolutely contraindicated to apply any form of high frequency physical agent. Hence the choice of treatment falls in favour of TENS or IFT. Though the evidences so far are not so promising for IFT but the fact is majority of studies are performed over mechanically induced pain and the mechanism, mediators and effects of IFT may be involved differently in each case. This needs to be evaluated further. Clinical and logical fact states that perception of IFT is better than TENS owing to its frequency bandwidth with low

frequency proposed to be produced over the target tissue. Adjusting variable beat frequency is believed to work on sensory nerves - A δ and C fibres, oedema reduction, vasodilatation and muscle contraction. A double-blind, randomized, controlled, multicenter trial by Altamaz et al on 203 patients who were given TENS, IFT and SWD, suggest that the use of physical therapy agents in knee OA provided additional benefits in improving pain because

paracetamol intake was significantly higher in the patients who were treated with 3 sham interventions in addition to exercise and education [26].

The dose parameters for acute onset of pain at knee can be adjusted to work on pain gate mechanism with beat frequency adjusted between 90-130 Hz and technique of application selected to 4 pole with knee joint in between the electrodes as shown in figures 1 & 2. Electrode placement should be such that both the channels are perpendicular to each other.

Once the pain reduces, one may start using a broader sweep in order to stimulate motor nerves to improve muscle activation, reduce oedema and improve vasodilatation as discussed earlier and hence beat frequency gradually can be increased up to patient receiving 10-100 Hz rhythmic. It is also said that increasing the variable beat may reduce overall effect at the affected area. To overcome this, treatment time may be increased with initial ten minutes of treatment at 90-130 Hz and then for rest of 10 minutes treatment to be given with variable beat frequency between 10-100 Hz.

In case of chronic pain, which is commonly seen in OA, one may need to enhance opioid mechanism. So the frequency of 2-5 Hz can be used initially followed by introducing variable beat frequency.

Upon introducing muscle stimulation frequencies, the technique of application can be changed and a wider area including the muscle bulk of Quadriceps should be placed in between the electrodes as shown in figure

3. Scanning vector technique can be introduced to make sure the entire area is treated effectively.

If parameters of IFT are not optimum, improvement may still be seen which is attributable to the placebo effect.

More recently combination therapy is being used. Combination of therapeutic Ultrasound (US) with IFT enhances physiological effects of both the modalities. Both modalities are applied over the knee joint at the same time and both are part of the same circuit as shown in figure 4. Dosages of both these modalities are adjusted as per desired effects. US is to be applied over most painful region of the joint (the area overlying the affected aspect of the joint) and IFT electrode to be placed in order to cover the knee joint as a whole.

When the pain at knee subsides, knee kinematics will improve which leads to improvement in gait and hence function. It is to be noted that IFT cannot be the sole treatment for OA knee. It works as an adjunct to exercises and is applied in order to reduce pain and facilitate quadriceps action, which in turn will make patient more compliant for exercises.

A recent meta analysis has shown IFC, in conjunction with standard of care, which is therapeutic exercise, is effective in reducing pain and decreasing paracetamol intake in patients with knee osteoarthritis after a month of treatment. The therapeutic regimen of IFC with beat frequency of 80-100Hz for 20 minutes for two to five times a week can also be recommended. It is best to combine physical agents, such as IFC, with exercise in managing pain and improving function in patients with knee osteoarthritis. More studies with a larger sample size, longer treatment and follow up periods may be beneficial for future randomized controlled studies on the effect of IFC on knee pain and function in patients with osteoarthritis [27].

Case Studies

Case 1

45 year old housewife came with complaint of

knee pain since one month. Pain began suddenly following her journey from USA. She presented with pain which on VAS scale was 5 at rest and 8 on activity. There were signs of joint effusion and pain restricting all her activities of daily living. Radiographs suggested OA knee grade 1. Her primary impairment was pain. She would not cooperate for exercises on day one of her visit if we did not work for pain relief. Her pain intensity suggests that we should treat her with IFT which works on pain relief by pain gate mechanism or working on sensory nerves as per Brenda Savage. Hence she should be treated initially with 4 pole technique with knee joint in the centre. Beat frequency initially placed between 100-130 Hz. Once pain starts subsiding, adding a variable beat frequency to work at different frequencies until one reaches a beat frequency of 10-100 Hz and to enhance the effect of every frequency selection, treatment time may be increased such that for initial few minutes she receives beat frequency 100-130 Hz and the latter half of treatment given with 0-100 Hz beat frequency and while a variable beat frequency added to the treatment, the electrode placement may be changed to include Quadriceps in the field and adding a vector scanning technique. IFT cannot substitute exercise regimen. But exercises may be started once pain subsides to a tolerable level.

Case 2

Fifty eight year old obese lady came with complaint of pain around knee. By occupation, she was a peon in a government office and had to climb stairs often. Her knee pain on activity was 6 especially during stair climbing over medial tibio-femoral joint and inferior patella-femoral joint. There were audible crepitations present. No swelling was seen apparently. Radiographs suggested OA knee grade 2. To summarize, her problem list included pain and difficulty to work mainly due to pain. This seems to be a simple case to treat wherein the first thing a physiotherapist

would think would be Quadriceps strengthening and proprioceptive and stabilization training. But the most important aspect to treat is pain because that seems to be her primary impairment. Adding IFT over knee to this patient reduced pain as a result of which she co-operated well for exercises which otherwise was difficult for her. She was treated with 4 pole vector electrode technique covering Quadriceps muscle as well and a beat frequency adjusted to 0-100 Hz right from day one of treatment. Rationale of this was she had a chronic or mechanical pain around the joint which was moderate. Pain was because due to degenerative changes, there must be postural alterations, affected arthrokinematics and abnormal kinetics and kinematics during gait. The main aim of her treatment was pain improvement along with Quadriceps muscle activity in order to work on abnormal mechanics.

In both the above cases, though the condition to be treated was OA knee and IFT chosen as the modality of choice, both the patient's clinical presentations were different and dosimetry was selected and progressed accordingly. Furthermore, though the stage of OA in case 2 was worse than case 1, it was the intensity, type and cause of pain that was treated. Case 1 had pain due to a well defined pathology called inflammation and joint effusion and so was treated as per parameters of acute pain, Case 2 had chronic pain, the cause of which could not be defined, though partly attributable to mechanical changes and rest of it attributed to central sensitization mechanism, the dosimetry was selected accordingly.

Conclusion

It is the time to revisit electro-physical agents and to reassert their value as one of the pillars of Physiotherapy. Though recent research trend is not very favourable towards the use of electro-physical agents, appropriate agent, dosimetry and technique of application could definitely yield a satisfying response.

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