Myofascial Pain syndrome: A Comparison of Two Non-Invasive Treatment Techniques

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Introduction

Myofascial pain syndrome (MPS) is a focal hyperirritability in a muscle that can strongly modulate CNS functions. Myofascial trigger points (MTrPs) can be defined as a hyperirritable locus within a taut band of skeletal muscle that is painful to palpation, reproduce the patients symptoms, and cause referred pain[1]

Epidemiological studies suggest that MTrPt pain is an important source of morbidity in the community. Researchers has also concluded that 82% of patients suffering from reflex sympathetic dystrophy demonstrated myofascial pain and treatment of the tender spots and TrPt component improved the outcome of this intractable condition[2]. The associated autonomic dysfunctions including abnormal sweating, lacrimation, dermal flushing and temperature changes makes the diagnosis and management issues more complicated[3]. Cervical myofascial pain may be associated with neuro-otologic symptoms including imbalance dizziness and tinnitus.[4] Other associated neurologic symptoms include paraesthesia, numbness, blurred vision, twitches and trembling[5]. Upper trapezius is the muscle that most frequently contains trigger points [5,6,7] and almost always contribute to head and neck pain complaints [8,9]. Upper trapezius trigger points may also be one of the most painful sites as there is a tendency for points in the nape region to have the lowest pressure pain threshold [10]. The high predilection for tender points in the upper middle area of the trapezius may be due to the fact that it contains fewer mitochondria per volume of muscle fibers than other muscle. The mid-trapezius area also marks the critical angle of neck lateral bending and postural fixation for movements of the arm, which result in increased tension.[11]

Simons et.al[12] and Mense[1] have contributed in explaining the pathophysiology of the MFPS and formation of TrPs using the energy crisis hypothesis and integrated hypothesis. The excessive release of intracellular calcium[13] in certain muscles and a pathologic increase in release of acetylcholine (ACh) by the nerve terminal of an abnormal motor endplate[4] is supported by electro diagnostic evidence [14] and this abnormality is considered to be the primary dysfunction in the "integrated hypothesis" proposed by Simons and Mense[1]. These hypotheses has been supported by studies that showed a low oxygen tension in the MTrPs region and a significant decrease in high energy phosphates coupled with an increase in low energy phosphates and creatine in a tender muscle site[15]. In summary the integrated hypothesis mentioned above is a positive feed back loop which starts with increased release of ACh at motor endplate due to mechanical trauma or chemical stimulation of the nerve terminal which induces a sustained sarcomere contraction. This results in localized ischaemia, which in turn results in the release of substance that sensitize nociceptors, produce pain, and induce release of neurovasoreactive chemicals. These chemicals leads to increase in ACh release sustaining the cycle[1,15,16].

The energy crisis hypothesis postulates that an initial insult, such as mechanical rupture of either the sarcoplasmic reticulum or the sarcolemma, would release calcium that would maximally activates actin and myosin contractile activity[12]. This together with the above discussed abnormal depolarization of the

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post junctional membrane due to excessive ACh release, results in a maximum indefinitely sustained contracture of the muscle fibers in the vicinity of the motor endpoint without motor unit action potential. [1,15,16]

Based on this hypothesis, the TrP region should (i) be higher in temperature than surrounding muscle tissue because of increase energy expenditure with impaired circulation to remove heat; (ii) be a region of significant hypoxia because of ischaemia; (iii) have shortened sarcomeres.

Some authors are of the opinion that TrP may result from or be irritated by trauma[12,17], overuse, mechanical load, postural faults or psychological stress. [18]

Through, central sensitization in the spinal cord new MTrPs or satellite MTrPs[12] may develop. Finally spontaneous pain may spread to many distant regions in addition to the original reference zone through the mechanism of central sensitization in the spinal cord[15]. Researchers have successfully treated satellite TrPs by injection therapy to the primary trigger point.[19,20]

The concept of MTrPs and associated research and clinical trial has improved our understanding of the pathogenesis of myofascial pain.[4,15,21,22] However the clinical efficacy of treatment to alleviate pain has not been well established. Regardless of the underlying mechanism of trigger point origination, the treatment of MPS is usually directed to the trigger point in the palpable taut band aiming at reducing its sensitivity. Conventional non-invasive treatment includes manual therapy,[23] electrotherapy,[24] cold,[12] and heat therapy and exercise therapy.[25,26,27] Two commonly used non-invasive treatment techniques are ultrasound (US)[12,28,29,30] and Trigger point pressure release (TPPR) which was previously known as ischaemic compression(IC).[12,31,32]

Ischaemic compression(IC) as described by Travell and Simons[12] is the application of sustained pressure to the trigger point. The pressure is progressed as the pain of the trigger point abates. The mechanisms which may explains the efficacy of this manual therapy includes 'neurological overload', the release of endogenous morphine like products (endorphins, enkephalins) as well as 'flushing' of tissues with fresh oxygenated blood following the compression.[33]

Ultrasound (US) is a common treatment modality that has traditionally been used by the physiotherapist for the treatment of MTrPs because of its deep heating effects with added benefits of its non-thermal properties.[12] Evidence in support of the use of US for the treatment of MTrP is at best mixed.[25,28,29,30]

The stretching techniques used in the conventional treatment was described by Lewit K.[33,34], well known as post isometric relaxation and is a form of muscle energy technique. Travell and Simons have recommended this technique[12] as an effective adjunct to myofascial therapy. This technique includes taking the muscle to the point of taking a slack, doing a submaximal isometric contraction and relaxing it and augmenting the relaxation using coordinated breathing techniques.[12,33]

Statement of the Problem

We know from the experimental evidences and suggestions by experienced authors that TPPR should not exceed the pressure pain threshold. Even though Hou [32] has recommended optimal pressure and duration, quantified delivery and duration for application of TPPR has been less investigated. The comparative study of TPPR as a prime modality was rarely found in the literature. Long term studies regarding the effect of TPPR on MTrPs was also rare.

The effectiveness studies of US, which were not supporting its usage, had methodological flaws in it. The studies, which compared the effects of US on MTrPs, failed to use parameters and guidelines of US application recommended by experts based on their well accepted empirical trails.

Two studies[25, 30] confronted, which compared US with variants of IC (transverse friction and deep pressure soft tissue massage) was having marked flaws in their studies and the application of US was not in par with the methodology explained by experts in myofascial therapy who advocates the use of US.[35, 36]

PIR has also shown its individual effectiveness

in the treatment of MTrPs[33]. It is usually used as an adjunct to other therapy for the MPS.

The purpose of this study on MPS is to; (1) determine the long term relative efficacy of a quantified TPPR over US which is applied as recommended by authors based on their recent investigations and(2)to compare these two treatments to conventional treatment consisting of stretching using PIR as described by Lewit.

Materials and Mehtods Participants

The study population comprised 30 patients (21 male patients and 9 female patients) with a mean (+SD) age of 25.6 (4.37) years. A relatively young population of patients was recruited to minimize symptoms that can be caused by accompanying degenerative disc and joint diseases. Majority of the participants were students (21). There was an imbalance of male participants in the sample (24>8). All had myofascial trigger points in one side of the upper trapezius muscle (20 right and 10 left). The participants were recruited consecutively from the department of physiotherapy, SVNIRTAR over a 3-month period.

Design

A mixed between group, pre-test post-test experimental design was used. The independent variable used in the study was type of treatment: (1) therapeutic ultra sound (2) trigger point pressure release, and (3) passive stretching.

To compare and contrast the different treatment the following dependent variables were used (i) the visual analogue scale, a measure of subjective pain intensity, is a card with an uncalibrated scale ranging from 0 to 10 on one side and a corresponding 10cm ruler on the other. It has been shown to be valid & reliable [37-40](ii) Pain free range of motion. A measuring tape will be used to measure the opposite side cervical side flexion. This method too is valid and reliable[41,42] (iii) pressure pain threshold, which is measured by an electronic algometer. Pressure algometry is also suggested as a reliable method of measuring trigger point sensitivity. [43-46]

Inclusion Criteria

1. Elicitable pain on application of digital pressure, referred from the ipsilateral and postero lateral side of the neck up to the base of the skull.
2. Trigger point in the Palpable taut band of upper trapezius muscle.
3. Compression of this trigger point should reproduce the patient's usual complaint (recognized pain).

Exclsion Criteria

1. No neck or shoulder surgeries in the past.
2. No clinical evidence of radiculopathy and myelopathy.
3. History of pain more than 2 years.

The 30 participants were assigned randomly into three groups after obtaining informed consent . Subjects in Group 1 were treated with ultrasound therapy, passive stretch and hot packs, in Group II were treated with trigger point pressure release, passive stretching and hot packs and in the Group III, which served as a control group, were treated with passive stretch and hot packs. All the participants in the three groups received the following exercise programs:

a) Active neck ROM exercise consisting of flexion, extension, both side flexion and rotations after the therapy.

b) Home programme consisted of active neck ROM and active stretching as per the appendix 1.

Instruments Ation

1) An electronic algometer (electronic engineering corporation, Chennai, India) was used to determine the pressure pain threshold of the trigger points and to deliver quantified pressure for TPPR. Pressure pain threshold is the minimal force that induces pain. Algometer is an instrument having 7x13x3 cm in size and a weight of 300 grams. The main panel of the instrument is connected to a sensor, which is having a strain gauge transducer with one square cm probe tip. The strain gauge is calibrated in kilograms and has a pressure range of 0.5 kg / cm^2 to 11kg / cm^2. The reading will be shown in the front panel as a digital display. Since the circular footplate area is 1cm^2,the reading shown in kilograms is numerically the same as

Kg/cm2, and thus no conversion is needed.

2) A horizontal VAS was used to measure subjective pain intensity. This is a card with an uncalibrated scale ranging from zero to 10 on one side (with zero representing no pain and 10 representing worst pain in life) and a corresponding 10 cm ruler on the other (with each cm representing one pain level). It has a pointer, which can be easily moved from one end to the other. It was moved by the patients along an uncalibrated scale. After the patients move the pointer into a position, the exact value of the pain intensity could be obtained by referring the uncalibrated scale to the ruler on the backside. Measuring to the nearest millimeter, the distance from the left-end mark to the subject mark on the line, with more millimeters indicating greater pain, scored the VAS.

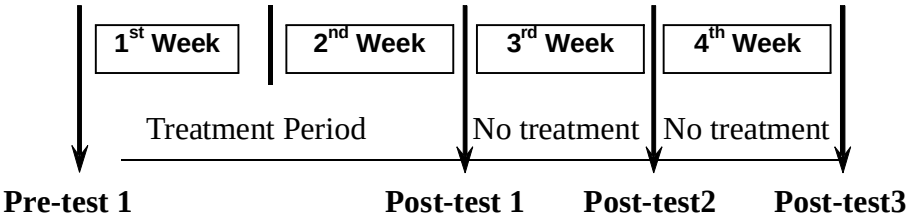
3) A measuring tape was used to measure the range of motion of cervical lateral flexion to the opposite side in centimeters. Investigators have measured side flexion to the opposite side previously also as an outcome measure for upper trapezius MF therapy. [32,26]

4) Ultra sound is delivered using a Sonopuls® 434 (Enraf-Nonius). This is an advanced apparatus with a microcomputer control, which ensures adequate acoustic contact with the help of a sensor. Possible deviation of power output from the pre set value is also automatically limited in such a way that variations never exceed 20% of the pre set value. A 1Mhz transducer is used with a surface area of 6.2 cm^2. It has an ERA of 5.0 cm2 and BNR of maximum 6.0.

A hydrocollator unit provided hot packs for the treatment. The unit had a thermostat, which was set at a temperature of 75°C. A semi permanent marker was used to mark the TP to reduce the error in application of ultra sound and TPPR. Marking test sides was thought to be one method of improving the reliability of PPT measurement. [47]

Procedure

After a thorough musculoskeletal assessment, if the patients fulfilled the inclusion criteria, they were voluntarily included as participants. Once they got selected they were explained clearly about the study and informed consent forms were given. After obtaining the informed consent a day before the commencement of the study, the participants were evaluated on the dependent variables for the first time. The following three more evaluations are as per the time line given below:



The dependent variables were evaluated totally four times-one before and three after the treatment period. The treatment was given for a period of two weeks consisting of ten-treatment session. The dependent variables were

The subjective pain intensity was measured first so that it is not affected by the other measurement procedures. The VAS was first explained to the patients and he or she was instructed to slide the pointer on the un-calibrated scale to a place he believes his pain is. After this is done the VAS card is turned to the calibrated side and the readings are noted down into the data sheet.

The opposite side flexion ROM of the neck is measured using a measuring tape in cms. The participant was asked to sit in a chair without an armrest with foot well supported and upper limb hanging by the side. He/she was requested to " try to touch your ear lobe to the shoulder without moving your shoulder or body". The participant was asked to stop and say "Yes" when it starts paining. The measurement is then

taken from the mastoid process to the lateral lip of acromion process of the scapula. Care is taken to prevent compensatory movements like shoulder shrugging or trunk side flexion.

The PPT is measured using the electronic algometer. The participant was seated well supported and relaxed while investigator stood behind the chair. He/ She was asked to point out the area of maximal pain. The investigator then searched for the most active trigger point by palpating with a fingertip. When the trigger point was found its boundaries was marked using an indelible marker. The rubber tip of the transducer is placed exactly over the trigger point and it was ensured that the shaft of the sensor is perpendicular to the muscle belly. Standardized instruction was given prior to each trial on all occasions. Participants were instructed to "report as soon as the sensation of pressure changes to pain by saying 'Yes', and I will stop". The investigator ensured proper contact of the trigger point with the tip of the transducer by keeping his thumb and index finger on either side of the trigger point with transducer tip in the middle. The other hand of the investigator held the shaft of the transducer in position. The pressure was then increased continuously by an equal space of 1kg/cm^2/s. When the participant responded by saying "pain" the value was noted from the digital display and he/she was asked to remember this level of pain discomfort and to apply the same criterion for the next measurement and treatment using TPPR. Three repetitive measurements at an interval of one minute were performed and the average of the readings was used as the PPT for data analysis.

After all the dependent variables are measured and the trigger point in the unilateral upper Trapezius marked, the participant was asked to come the next day. The treatment session started the next day. All the three groups received their respective treatment and all were trained in performing active ROM exercises of the neck and active auto stretching of the upper Trapezius muscle. A hand out for these active exercises was given to the patient on the first day.

The TPPR group received the treatment using the electronic algometer. Using the algometer the pressure delivered to the TP was quantified. First day treatment was delivered with the same PPT, which was found on the first pre test day. Thus every treatment pressure was same as that day's pressure threshold.

Similarly the participants in the ultrasound group received insonation. Frequency 1MHz, continuous, intensity 1 W/cm^2 to 1.5 W/cm^2. Duration of insonation is 8 minutes. Treatment head of 6.2 cm^2 diameter will be moved 2 – 3 cm/second during insonation and tolerable pressure is applied through the treatment head during the treatment time. It is made sure that patient feel warmth throughout the treatment time. Upper trapezius muscle will be kept in tolerable stretch position during ultrasound application.

The patients were asked to report any mild increase in temperature by raising his/her opposite side hand. He/She was asked to raise the hand for the second time if heat is more. The transmission gel was applied on the part marked by the indelible marker. The transducer head was kept on it and the intensity was slowly increased to maximum of 1.5 W/cm^2 or till the participants reported warmth. This perceived sensation of warm was maintained throughout the treatment time.

The control group received stretching using PIR of the upper Trapezius muscle as described by Lewit.

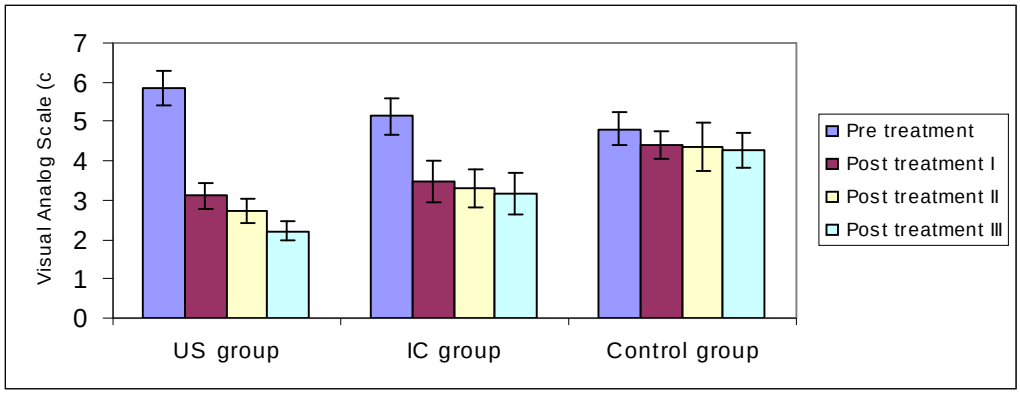
Both the Group1 and Group2 participants were given the above described passive stretching in addition to their respective treatment. All the Three groups were asked to do active ROM exercises as described in the protocol just after finishing the passive stretching. After finishing the active ROM all participants was given a hot pack.

Data Analysis

Data were analyzed using a 3x4 ANOVA, where there was one between factor (treatment groups - Ultrasound, Quantified TPPR and post isometric relaxation) with three levels and one within factor (time - pre test, post test I, post test II and post test III) having four levels. Post hoc comparisons were evaluated using Tukey's HSD using a significance level of 0.05.

Results

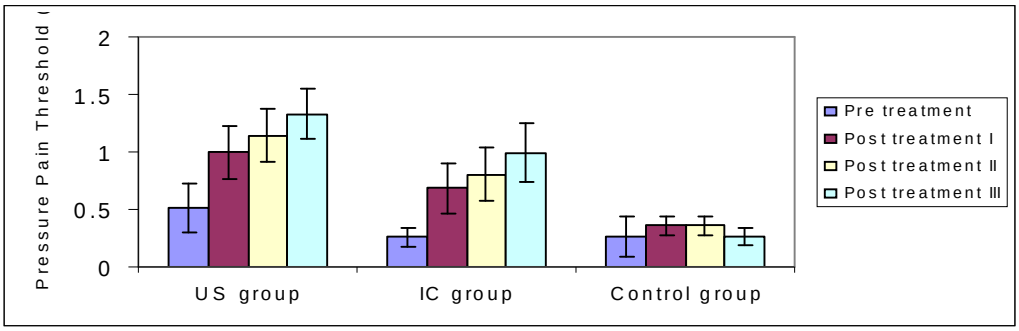
Visual Analog Scale Graph 1 - Visual Analogue Scale



Graph 1, illustrates that the US and the TPPR group improved significantly when compared to the control group which received post isometric relaxation using Lewit's technique. There was a main effect for the time $F_{(3,81\ ;\ 0.05)}$=85.706,p<.01, but the main effect for the group did not achieve significance level, $F_{(2,27;\ 0.05)}$= 1.516,p<.238.However, the main effects were qualified by the group x time interaction, $F_{(6,81;\ 0.05)}$= 16.358,p<.01 . Tukey's HSD showed that both the US and TPPR group improved with treatment to a greater extent when compared to the control group. Also the US group had greater reduction in the VAS score as compared to the IC group. This improvement in pain perception scores moreover was sustained over a period of time where no treatment was given.

Algometry

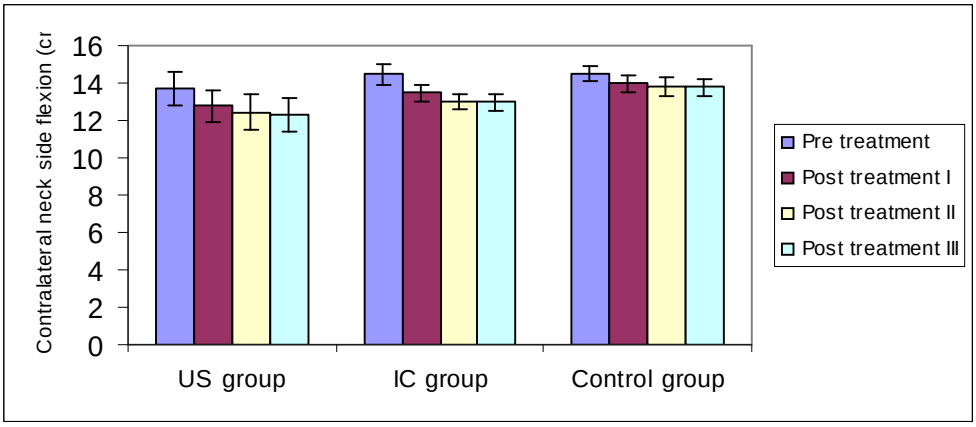
Graph 2 - Pressure Pain Threshold.



Graph 2, depicts that the US group improved significantly when compared to both the TPPR group and the control group which received post isometric relaxation using Lewit's technique. There was a main effect for the time, $F_{(3,81\ ;\ 0.05)}$=44.094,p<.01 and there was also a main effect for the group, $F_{(2,27;\ 0.05)}$= 3.880,p<.033. However, this main effect was qualified by the group x time interaction, $F_{(6,81;\ 0.05)}$= 10.053,p<.01. Tukey's HSD showed that the ultrasound group improved to a greater extent when compared to both the TPPR group and the control group. Moreover, this effect of increased pressure pain threshold was also sustained in the ultrasound group when compared to the TPPR group and control group after stopping the therapy suggesting the presence of long time effect of ultrasound.

Contralateral side flexion ROM of the neck

Graph 3 - Neck Side Flexion.



Graph 3, illustrates that the US group and the TPPR group improved significantly when compared to the control group which received post isometric relaxation using Lewit's technique. There was a main effect for the time, $F_{(3,81\ ;\ 0.05)}$=99.309,p<.01, but there wasn't a main effect for the group, $F_{(2,27;\ 0.05)}$=0.915,p<.412. However, this main effect was qualified by the group x time interaction, $F_{(6,81;\ 0.05)}$= 4.049,p<.001. Tukey's HSD showed that ultrasound group and the ischemic compression group improved to a larger extent when compared to the control group. This effect of ultrasound and ischemic compression was also sustained even after stopping the therapy. In addition and importantly the US group had greater improvements in motion as compared to the IC group.

Discussion

Overall, the results of this study suggest that patients who have myofascial pain syndrome improve when treated with US and IC techniques. Moreover, this treatment effect is sustained over a follow-up period of two weeks when no treatment was given. In addition and more importantly, it was found that US had a far superior effect than IC and stretching alone. The results of this study correlate with other studies[28, 29,48], which were done on MPS suggesting that ultrasound therapy is effective and in contrast to results reported by Hong et al[30] Gam et al[25] and Esenyel et al[26].

One recent study by Hou et al [32] compared 30 sec., 60 sec. and 90 sec. duration of TPPR with two pressure loading; pain threshold and averaged value of pain threshold and pain tolerance. He found that the lower pressure pain threshold (PPT) level for duration of 90 sec. was effective in obtaining pain relief. The pressure that is applied to the MTrP of taut band should be within a tolerable pain level for individual patients to avoid causing excessive pain and autonomic responses with involuntary muscle tensing. [3,35,82] Therefore, an appropriate pressure prescription is important to ensure the clinical efficacy of TPPR therapy. A quantified delivery of pressure for a specific duration to the TrP also ensures replicability of the same method in clinical practice or controlled trails. Even though algometer were extensively used for the outcome measure of myofascial therapy, it has been rarely used as a measure to quantify the delivered pressure during IC to a MTrP.

Hou's study was comparing the immediate effects of physiotherapy on cervical myofasical pain and TrP sensitivity and compared six combination of seven therapeutic modalities ie; hot pack, active ROM, IC, TENS, stretch and spray, IFT and myofascial release. They found that immediate relief can be obtained in all combination and the most effective was the combination of hot packs plus active ROM, IC, and TENS. It was not clear whether the immediate effect was attributed to IC or TENS. The long term effects of these modalities were not considered in this study. There was a need to investigate the long term effectiveness of TPPR after a quantified delivery of pressure which is

equal to the PPT for a duration which was found most effective by Hou et al.

Hanten et al[49] conducted a study on fourty adults with MPS and compared the effect of a home programme of IC followed by sustained stretching with a control treatment of active ROM. The IC group demonstrated the effectiveness of IC in reducing TrP sensitivity as measured by algometer and pain intensity scored with a VAS. The idea of giving a type of manual therapy like IC as a home programme is defended by the statement "We believe that the patient should be involved in his or her treatment, acting as the primary pain manager". Another advantage of home programme is that it reduces physiotherapy visits. The study was not designed to distinguish the relative contribution of IC from those of stretching exercises. The reliability of MTrP examination has been strongly criticized by other authors. [50-52] Given the fact that TrP identification has less reliability, the patient finding the taut band and the trigger point and applying IC consistently for 5 days using a theracane in a successful manner is questionable. Hypersensitive patients also may tend not to press at a site where they have more pain.

Garvey et al[31] compared the effect of injection of a local anesthetic, injection of a local anesthetic plus steroid, acupuncture and acupressure with vapocoolant spray on MTrPs. The authors found that the acupressure plus vapocoolant spray, their control procedure was the most effective at relieving pain. Some authors identify the acupressure as ischaemic comparison[53].

Direct comparison of this study's results regarding TPPR with those studies which used variants of ischaemic compression is only possible in a general way due to gross difference in the technique of application. Even though the techniques were different almost all studies which included IC and its variants had positive results [31,32].

Nussbaum[54] and Robertson et.al.[55] reported that US is one of the most frequently used electrophysical agent in physiotherapy practice. Despite its frequent use, firm evidence on its effectiveness from randomized control trails seems to be lacking. Therefore the effectiveness of US therapy remains controversial [56,57].

Based on a meta-analysis of 22 control trails published until 1991, Gam and Johannsen[57]concluded that there was little evidence for the effectiveness of US therapy from well designed trails. In their meta-analysis, the results of trails on a wide variety of disorders including lateral epicondylitis, osteoarthritis knee, breast pain after delivery and traumatized perineum were summarized in one analysis, disregarding the possibility that the effectiveness of US therapy may vary across specific disorders.

Another systematic review by Windt et al[36] evaluated the effectiveness of US in the treatment of musculoskeletal disorders. They included 38 studies in this review and concluded that there is little evidence to support the use of US in the treatment of musculoskeletal disorders.

Robertson and Baker [58], based on their meta-analysis concluded that active US is no more effective than placebo US for treating patients with pain or musculoskeletal injuries. The authors came into this conclusion after reviewing 10 studies of which 8 showed that US is not effective. Draper[59] and Merrick[60] have commented on the flaws of this review. Draper[59] found flaws in all the eight original studies from which the authors drew this conclusion. Draper has studied extensively on US for about a decade. [61-64] To obtain optimal US benefits, the treatment area size should be no more than 2 times the size of the effective radiating area of the crystal (ERA)[61]. (ERA is the area of crystal that transmits the sound wave) Only one of the studies accepted by Robertson for the review considered this factor. Similar flaws were there in selection of the frequency of the treatment head and duration of the treatment.

For the majority of the thermal effects of US to occur, the temperature should increase to a therapeutic range of 40°C to 45°C. [60,65,66] Other studies [67,68], reported that a 1°C rise of temperature from the base line increase metabolism and healing, 2°C to 3°C decreases pain and muscle spasm and 4°C or greater increases the extensibility of collagen and decrease joint stiffness. Based on calculation by Draper[64] 1 MHz US at 2.5 W/cm^2 for 3 minutes

(2ERA) would increase tissue temperature only 1.2°C. The increase in temperature depends on duration and intensity of insonation[61]. Out of the 10 studies accepted by Robertson for the review, 7 used pulsed mode for insonation. Thus they have failed to heat the tissues by not taking into consideration the size of the treatment area, duration of insonation, frequency of the treatment head and percentage of sonation. The two studies that showed that active US is superior, had the longest treatment time of 15 minutes. Therefore any study which addresses the clinical efficacy of US should strictly adhere to all these parameters which is scientific. A study is flawed to begin with if correct parameters are not used.

Evidence in support of the US for the treatment of MTrPs is mixed. Five studies was confronted out of which 3 supported, [28,29,48] two contrary[25, 30] to and one neutral[26] about the use of US for the treatment of myofascial pain.

Lee Lin and Hong[48] did a study on the immediate effects of US and electrical stimulation compared to electrical stimulation only for the treatment of MTrPs. They found that the range of stretch of upper trapezius muscle was significantly increased immediately after the application of US and electrical stimulation compared to the group, which received electrical stimulation alone. Esposito et al[28] and Talaat et al[29] also supports the use of US for the treatment of MPS. Esposito evaluated the effects of US on 28 patients and found that it was effective in alleviating discomfort of MPS that does not respond to occlusal splint therapy used in dentistry. Talaat studied a population of 120 patients who has MPS who were randomly assigned into three equal groups treated by muscle relaxant drugs, short wave diathermy, and US therapy respectively. This was a long term study with regular follow up for 6-12 months. Results revealed marked relief of symptoms by the use of physiotherapy and the best result were obtained by the use of ultrasonic therapy.

Gam et al[25] investigated the effect of ultrasound, massage and exercise on MTrPs. The authors did not find any difference between the experimental groups and the control group and thus concluded that US give no pain reduction, but apparently massage and exercise reduces the number and intensity of MTrP.The outcome measures in this study were VAS, a tender point score with three points, daily analgesic use and a follow up questionnaire for long term effects. The reliability of the tender point score and the analgesic usage as a treatment outcome measure is questionable. Algometer was not used to measure the individual trigger point sensitivity.The US frequency they used was 1MHz, Pulse mode 2:8, 3 W/cm^2 for 3 minutes. Using 1MHz was an ideal decision because of the increased depth of penetration, but using pulsed mode with a mark space ratio of 2:8 delivering only 20% of the US energy lacks empirical support. The thermal effects of pain reduction, [55,69] increased perfusion, [68, 70] decreased spasm, [69,71] increase in the extensibility of the fascia[72,73], which has more of collagen and alternation in nerve conduction velocity[74] may have an effect on the painful, hypoxic, tense MTrP. As the output of the US was pulsed no thermal effect would have occurred. Provided the fact that thermal dose can also cause non-thermal effects[74] there was no need of a pulsed output. The tissue temperature should increase to more than 40°C for therapeutic benefits[66] and it depends upon the duration of insonation also. [61] Draper's study [59] has proved that insonation using continuous mode, 1 MHz sound head at an intensity of 2.5 W/cm^2 for 3 minutes (2ERA) would increase tissue temperature only 1.2°C. So this study despite using 3W/cm^2 would not have reached the therapeutic range because of pulsed mode and shorter treatment time. Thus Gam failed to use contemporary US methodologies rooted in experimental literature. [59,60-66]

Esenyel et al[26] in his recent study on myofascial pain investigated the effectiveness of US treatment and trigger point injection in combination with neck stretching exercises on myofascial TrPs of the upper trapezius muscle. One hundred and two patients were randomly assigned into one of three groups: group 1 received US therapy to the TrPs in conjunction with neck stretching exercises; group 2 received TrP injection and neck stretching exercises; and group 3, the control group, performed neck stretching exercises only. Outcome measures were VAS for subjective pain intensity,

algometer for pressure pain threshold and a goniometer for ROM of the upper trapezius muscle. This too was a long-term study with follow up for 3 months. In the conclusion the authors reported that when combined with neck stretching exercises, US treatment and TrP injections were found to be equally effective. The intensity of US was 1.5 W/cm^2 for 6 minutes duration. This could be an acceptable dosage if the treatment was twice the size of ERA but, the authors reported that they sonated the trigger point as well as the pain referral zone for a total time of 6 minutes. Pain referral zone of the upper trapezius is found to be extending to the side of the head and postero lateral part of the neck as well as the angle of the jaw[1]. This duration and area of US application is in contrary with Draper's research findings and Robertson's recommendation regarding sonation of a TrP.

From all the studies reviewed, Hong's[30] study was one among those which compared a variant of ischaemic compression with US therapy. Hong et al evaluated the immediate effects of four commonly used modalities used by physiotherapist who treat MTrPs. The modalities they tested included stretch and spray, moist heat, ultrasound, and deep pressure soft tissue massage. The investigators concluded that also four modalities were effective in the treatment of MPS and deep pressure soft tissue massage was the most effective modality. Robbins[75] had critically appraised Hong's study and stated that the results are highly inconsistent with his clinical experience. He states that the unexpected results may be due to rapid movement of the US head and large area covered during a small duration of 5 minutes. Robbin's based his arguments on Dr. Lowe's teaching of ultrasound treatment of the TrPs.[35]. Hong states that US was applied to the upper trapezius area of approximately 40-50 cm^2 with the TrP at the central portion with an intensity of 1.2 – 1.5 W/cm^2 for a duration of 5 minutes. He moved the ultrasound head 3-5 cm/sec and made sure that the patients always felt warm during therapy.The intensity of 1.2 – 1.5 W/cm^2 would have been an effective dosage if the duration was more. There are studies which proved in vivo that when 1MHz US was given with gel as a coupling medium with 1.5 W/cm^2 intensity in a continuous mode took 8 minutes to heat the tissues to a therapeutic level of 40°C[62]. This temperature rise was when 2ERA was insonated with the head moving 4cm/sec. Thus it is unlikely that the area covered by Hong (40-50cm^2) reaches the therapeutic range of temperature. All the other methodology used by Hong for the application of US is acceptable as per the recent research findings.

The superior outcome and the carryover effect found in the patients who received US may be attributed to the parameters used in this study. The thermal dosage, [60,65,66] duration, [61,62] surface area insonated[61] the speed of movement of the transducer[76,77] have all been suggested to be effective experimentally. The stretching of the insonated muscle and giving a comfortable pressure using the US head during US application has been recommended by several researchers in the treatment of MTrPs with US [35]. It is suggested that outcome studies that use US should follow the parameters, which have been shown to be effective. '

Subjects in the control group which received post isometric relaxation exercises improved from pre treatment to post, however the degree of improvement was much less than when compared to the US and IC groups. This finding is contrary to what was reported by Lewit and Simons[34]. They found immediate improvements in the patient's symptoms after the application of post isometric relaxation. This may be because of the fact that this muscle energy technique needs a greater skill when applied to a painful muscle and thus discrepancies in the application of the technique may have led to a lack of an optimum effect.

Considering the fact that the recent literature as well as this study supports US as well as soft tissue techniques like deep pressure massage, friction massage, acupressure and ischemic compression, a combination of these two treatments may be a better approach for the effective treatment of MPS. US transducer can be used to give pressure massage during the insonation time and this will be convenient for the busy clinician. Algometer was used in the study for delivering ischemic compression where the pressure was maintained at a constant threshold level for 90 seconds. But this technique

compromises on the feed back sensation when using the therapist hand to deliver ischemic compression that is necessary to vary the pressure as the threshold increases. The above speculation's, however are beyond the scope of this study.

Consclusion

Both US and IC were effective in reducing pain intensity, increasing pain threshold and increasing range of motion of upper trapezius muscle, though US was found to be superior than IC in showing improvements with regards to the outcome variables measured, including the long term effects of the same. These results were in contrast to a number of similar studies. The discrepancy could be due to the difference in parameters and method of application of the ultrasound therapy. There are high variations in the application of therapeutic US even though, it is one of the most widely used modality. This may lead to unreliable and inconsistent results. This study demonstrates the benefits of choosing dosage as per experimentally proven norms and suggests the use of same for therapeutic purpose.

Finally, the use of the two treatment techniques has been found to be beneficial in young population having myofascial pain syndrome however, a small sample size and a larger number of male subjects compromise on the external validity of the study. The adding of functional status measurement would have shown whether or not the quantitative improvement in the patients' status was transferred to his daily activities. It is believed that the duration of treatment effectiveness in MTrPs varies from case to case because the incidence of MTrPs is usually associated with underlying pathologic lesions, postural problems and structural abnormalities. Because of these factors, investigating the long term effectiveness of MTrPs treatment is difficult. It seems to be necessary to conduct a randomized control long-term study, which would successfully control the perpetuating factors. Recent studies, which improved our understanding of autonomic and emotional contribution of muscle pain, necessitate a study, which considers these factors by including psychotherapeutic or behavioral approaches in the treatment of these muscle pain syndromes.

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