Effect Of Cycle Ergometer On Gait Of Individuals With Spastic Paraplegia

Meenakshi Singh
Lecturer, Amity Physiotherapy College, Delhi

Study design

Randomized clinical trial

Background

Passive movements performed rhythmically by cycle ergometer claim to have an effect on spasticity reduction, but faster cadences have rarely been investigated for their effects on spasticity.

Purpose

To evaluate the effect of varying cadences of cycle ergometer on gait parameters i.e. walking speed, cadence, stride length and step width of spastic paraplegic subjects.

Setting

Rehabilitation department, Indian Spinal Injuries Center, New Delhi.

Subjects

20 subjects with Thoracic (T7-T10) spinal cord injury.

Material

Cycle ergometer (MOTO med exerciser), paper walkway, ink, measuring tape, and stopwatch.

Methods

Two groups A & B were formed. Group A (control group) underwent cycling for 40 min. at a cadence of 30 rounds per minute (rpm). Group B underwent cycling for 40 min at a starting cadence of 30 rpm with increasing velocities every 10 min., 45%, 55% and 65% finally reaching to 50 rpm for two weeks each day for 5days/week. Gait analysis was preformed after the gait training in both the groups.

Outcome measures

Walking velocity, cadence, stride length and step width were recorded using ink- footprint record and ambulation time.

Data analysis

A paired t-test was used to analyze the differences between gait outcomes. Correlation co-efficient analysis was done to find out the relationship between gait parameters.

Results

A Significant difference existed in all the gait parameters. Experimental group had increased velocity, stride length and step width but reduced cadence than control group. ($p < 0.05$ for each parameter). Velocity and cadence were highly correlated with one another ($r > 0.75$).

Conclusion

Passive cycling at higher speeds has positive effects on gait outcomes of spastic paraplegic individuals, which leads to attainment of functional gait and hence, better quality of life in paraplegic patients.

Key words

Spinal cord injury, paraplegia, cycle ergometer, spasticity, and gait.

Reprint requests: Dr. Meenakshi Singh (PT)
MPT (Neurology), MIAP, S- 640, school Block, Shakarpur, Delhi-92.
E-mail: msphysio@gmail.com

Introduction

Spinal cord trauma or disease may result in an incomplete/ complete active functional inability to stand up and to walk. Walking, an important activity of daily living, is a mode of bipedal locomotion in which a period of double support, when both feet are in contact with the ground is followed by a period in which the body is supported by one lower limb while the other is swung forward. [1]

It is well established that the major functional loss following injury to the thoracic spine is the inability of the patient to independently stand up & walk in the environment encountered while engaging in normal daily activities. [2]

Also, after the stage of spinal shock is over, there are various concomitant symptoms which provide hindrance to the spinal cord injury patient to stand and walk. They include contractures in hip, knee and ankle; the formation of heterotrophic ossification of these joints; pressure sores; spasticity; decreased cardio circulatory and pulmonary function and frequent urinary tract infection due to stagnation of fluids in the bladder. [3,4]

Of these, spasticity is the biggest hindrance for a paraplegic patient to achieve even an upright stance. Spasticity is defined as a symptom of upper motor neuron syndrome characterized by an exaggeration of stretch reflex secondary to hyper excitability of spinal reflexes. [5]

65-75% of individuals with chronic SCI have symptoms of spasticity. In individuals with thoracic spinal cord injury, 72% of those diagnosed as ASIA A and 73% of those diagnosed as ASIA B-D reported symptoms of spasticity.[6]

Spasticity has the potential to negatively affect quality of life through restricting ADLs, inhibiting effective walking and self care. Severity of spasticty is the degree to which walking is effective in functional ambulation after spinal cord injury.[8]

During the past four decades, several interventional strategies have been developed to reduce spasticity in spinal cord injury individuals. These include use of therapeutic stretching; strengthening; serial casting; Positioning; neuromuscular electrical stimulation; aquatic therapy; nerve blocks; medication and surgical intervention.

Although, all of these measures have been effective yet these have some side effects and also the positive effects are not long term. [7]

Motorized exercise cycle has been used to reduce spasticity. Passive movements, when performed rhythmically by cycle ergometer, claim to have an effect on spasticity reduction. Half an hour cycling intervention reflects a change in the reflex properties. Passive cycling has other physiological effects also such as improved blood flow to legs, better metabolic responses and improved aerobic fitness. However, pedal cadences have been limited to 25-30 rpm. Faster cadences have rarely been investigated for their effects on spasticity. It has been shown that pedaling at higher speeds resulted in decreased force output by the paretic limb. [9,10]

So, the main aim of the study was to evaluate the effect varying cadences of cycle ergometer on gait parameters i.e. walking speed, cadence, stride length and step width of spastic paraplegic subjects.

Review of Literature

There are three types of gait used- swing-to-gait, four point gait and swing-through-gait. Controlled walking is achieved only through perseverance, perfect timing, rhythm, and co-ordination. The patient is taught always to move the hands first, to walk slowly and place his feet accurately, to take the weight through the feet and to ensure that the hands can relax between each step, and to lift the body upwards and not to drag the leg forwards. For ambulation over even surfaces for four point gaits, the physical prerequisites are adequate strength in Serratus anterior, Pectoralis major, Latissimus dorsi and Triceps. Also, there must be full range of motion in elbow extension, hip extension and knee extension.[11,12]

Spasticity is a clinical triad of mass spasms, spastic hypertonus and hypereflexia. The physical therapist has a great many interventions at his/ her disposal to assist in managing the patient's hypertonicity. The foundation of spasticity management is therapeutic stretching and strengthening exercises with adjunctive modalities and functional retraining.[12]

Passive range of motion, positioning and serial/inhibitive casting assist in decreasing hypertonicity. Neuromuscular electrical stimulation will cause temporary inhibition of abnormally high tone. The electrical stimulation can be applied to either agonist/ antagonist muscles. Increased weight bearing on affected limb, rhythmic rotation and aquatic therapy have temporary inhibitive effects on hypertonicity. Botulinum toxin (botox) and Phenol nerve blocks are synergistic antispasticity intervention. Medications prescribed to treat spasticity include Dantrolene, Baclofen, Tizanidine, Clonidine and diazepam. Surgical intervention for spasticity management include orthopaedic Tenotomies as well as neurosurgical ablative and neurodestructive procedures.

Ergometer pedaling is an ideal functional exercise. The movement is significantly complex to provide a functionally relevant test for motor performance. Pedaling demands multisegmental co-ordination of bilateral reciprocal symmetrical lower extremity movements in which the muscles go through the periods of activity and subsequent passive lengthening. (13) Giuliani CA et al studied the effect of bicycle pedaling on the temporal-distance parameters and EMG characteristics of walking in hemiplegics subjects. They concluded that bicycle exercise does improve walking velocity and stride length. Potempa et al found increase in maximal oxygen consumption, work load and exercise time as well as lowering of systolic blood pressure during a sub maximal exercise.

A qualitative determination of the degree of tone is made by modified Ashworth's tone assessment scale. It is a six point ordinal scale. The scale has been shown to have high interrater reliability.[14,15]

Methodology

Number of subjects: a sample of convenience of 20 subjects with spinal cord injury.

Source of subjects: ISIC hospital, Vasant kunj, New Delhi.

The criteria for selection of subjects were:

Inclusion criteria

· Spinal cord injury subjects at least 3 months post injury with a stable spine and no significant kyphoscoliotic deformity.
· Neurological level from T7-T10.
· ASIA impairment grade A
· Spasticity grade 1+ to 3 on Ashworth's scale.
· Medically stable.
· Full Range of motion in hip, knee and ankle.

Exclusion criteria

* Any complication such as pressure sore, urinary tract infection, autonomic dysreflexia and postural hypotension.
* Visual impairment (if any, then successful use of corrective lenses)
* Any painful musculoskeletal or joint problems affecting upper limb.

Method of selection

All the spinal cord injury patients attending the rehabilitation department of ISIC hospital were evaluated and those meeting the inclusion and exclusion criteria and willing to give consent to participate in the study were included in the study.

The subjects were then randomly allocated into two groups: Group A (constant speed cycling) and group B (graded increase in speed of cycling).

Design of the study

Randomized Controlled Experimental Design.

Instrumentation for data collection

1. Cycle ergometer (MOTOmed exerciser)
2. Parallel bars with a length of 5 meters.
3. Digital stopwatch.
4. Oil paint
5. A standardized inch tape & scale.

Variables used in the study

Independent variable: Cycle ergometer

Dependent variables

1. Walking velocity
2. Cadence
3. Stride length
4. Step width

Procedure

Participants were explained about the purpose and nature of study and the informed consent was obtained from those willing to participate

Demographic details and the history like the name, age, gender, body weight, time since injury, ASIA level, functional leg length, spasticity scoring on modified Ashworth's scale for knee extensors, knee flexors and hip abductors was obtained.

Pre- experimental protocol

An initial gait assessment was performed for all the subjects within the parallel bars fitted with a 3 meter walkway. Walking velocity, cadence, stride length and step width were recorded using ink footprint record method and ambulation time.

Each subject initially walked from right to left and following a 45-60 second break for turning, walked from left to right. By noting the time spent walking to each direction, an average walking speed was obtained.

Numbers of steps per minute were counted to calculate the cadence.

Foot prints were taken with the help of oil paint applied on the sole of the patient. Stride length and step width were recorded.

Stride length was calculated by measuring the distance from heel strike of one extremity to the heel strike of same extremity again in the next step using a standardized scale. Stride length was divided by the functional leg length for each subject to normalize the differences in the patient's leg length.

Step width was calculated by measuring the linear distance between the mid point of the heel of one foot and the same point on the other foot.

Patient Seated on Cycle Ergometer.

Three trials were taken for each assessment and the mean for each outcome measure calculated.

Adequate rest periods were given in between the testing as per the patient's will.

Post experimental protocol

All the subjects were placed in their own wheelchair in front of the motorized cycle ergometer. Group A underwent cycling for 40 minutes at a cadence of 30 rpm. Group B underwent cycling for 40 min at a staring cadence of 30 rpm (rounds pre minute) with increasing velocities every 10 min. 45%, 55% and 65% finally reaching to 50 rpm.The regimen continued for two weeks (5 days/ week) gait assessment was done at the end of regime and the four parameters i.e. walking velocity, cadence, stride length and step width were recorded.

Data was recorded in the gait analysis recording form.

Data Analysis

Statistics was performed using the STATA 7.0 and SPSS software. A paired t test was used to analyze the difference between the performances of the subjects in the two groups A and B before and after the intervention, which showed a significant p- value ($p<0.05$). Correlation co-efficient analysis was done to find out the relationship between various gait parameters.

Results

Comparison of gait parameters between two groups:

There was a significant difference in velocity of both the groups before and after the intervention.

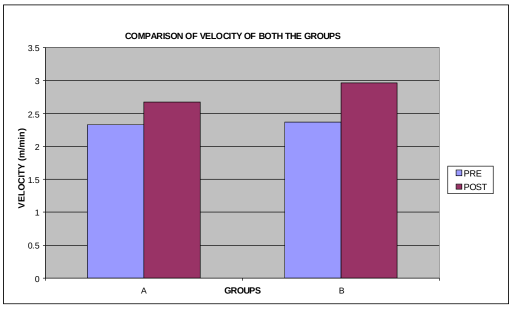
GAIT PARAMETERS OF GROUP A (CONTROL GROUP)

VARIABLE	PRE-INTERVENTION	POST INTERVENTION
VELOCITY (m/min)	2.33+- 0.30	2.37+- 0.28
CADENCE (steps/min)	11.7+- 1.05	11.9+- 1.09
SL/LEL	0.83+- 0.44	0.84+- 0.40
STEP WIDTH (cm)	3.58+- 0.79	3.62+- 0.94

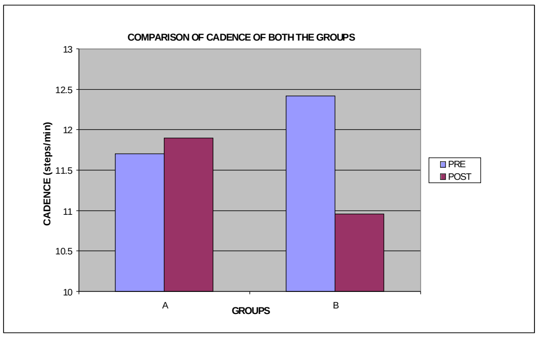
GAIT PARAMETERS OF GROUP B (EXPERIMENTAL GROUP)

VARIABLE	PRE-INTERVENTION	POST INTERVENTION
VELOCITY (m/min)	2.67+- 0.17	2.96+- 0.24
CADENCE (steps/min)	12.42+- 0.26	10.96+- 0.35
SL/LEL	0.81+- 0.48	0.88+- 0.74
STEP WIDTH (cm)	4.1+- 0.62	5.1+- 0.36

A significant positive correlation (r= 0.78) was found in group A when values of velocity were compared with values of cadence and group B (r=0.76) when values of velocity were compared with that of cadence.



GRAPH-1



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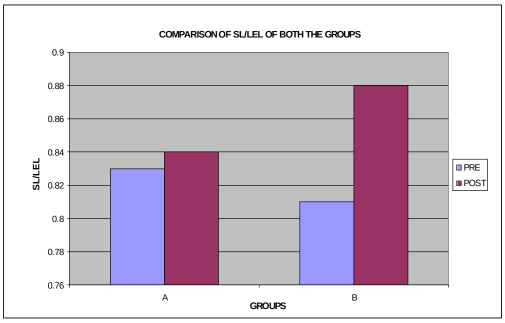

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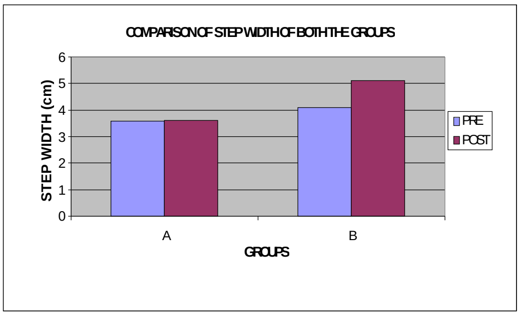

GRAPH-4

Discussion

In our experiment, we studied the effects of rhythmic passive cycle movements of the lower limb on spasticity. There was significant difference in gait parameters of subjects in the two groups. Experimental group had increased velocity, stride length and step width but reduced cadence than control group.

Motorized exercise cycle has been used previously to treat spasticity.Reflexive responses of spasticity strongly habituated during testing.[20] A clear distinction is made between the intrinsic muscle changes and the altered reflex properties that contribute to the heightened muscle tone. First factor seems to be dependent on the muscle mechanical moments and the passive viscoelastic elements and is very stable. Also, it includes fibrosis, muscle fiber atrophy, reduction in the elastic properties, decrease in the number of sarcomeres, accumulation of connective tissues and alteration of contractile properties. In contrast, the short term variation in torque is attributed to changes in stretch reflex properties.[21,2] This would imply that a half hour cycling intervention may reflect a change in the reflex properties which were subject to testing in the experiment.

With the passive cycling device, the knee is indeed flexed and extended during half an hour. muscles were stretched during the cycling but not to the end of range of motion.

Alpha neuron excitability develops secondarily after alternation of some other segmental mechanisms in those with spasticity (e.g. increased alpha motor neuron altered interneuron activity and decreased pre- synaptic inhibition).[23,24] Initially, it is the hyperexcitability of this tonic stretch reflex that is commonly thought to result in increased muscle tone in response to passive stretch following spinal cord injury. The development of tonic stretch reflex hyper excitability could be due to a lower threshold, an increased gain of the stretch reflex or a combination of the two. The resultant increase in muscle tone is thought to be due to a combination of increased denervation hypersensitivity and changed muscle properties. Denervation leads to an initial down regulation of neuronal membrane receptors followed by an up regulation of enhanced sensitivity to neurotransmitters.[25]

Heightened muscle tone is mainly due to intrinsic muscle changes half an hour cycling intervention at single speed would lead to a change in the phasic properties pf a muscle. Different velocity cycling would have an effect on muscle mechanical moments and the passive viscoelastic elements. Also there is an increased threshold of tonic stretch reflexes in which constant cycling has no effect.[26]

Faster stepping speed resulted in greater afferent feedback to the CNS which in turn may lead to up regulation of neuronal membrane receptors and hypersensitivity to neurotransmitters.

Physical therapists have traditionally believed that faster speeds might increase unwanted muscle activation or spasticity but there appears to be little evidence for this notion.

Increasing pedaling speeds at every 10 minutes required earlier onsets of muscle activity to reach peak force which lasted only for 1 minute, after which it decrease which may result form a decrease in synaptic transmission caused by inactivation of pre- synaptic calcium channels.

It was found that a reduction in resistance during repeated passive movements without concurrent changes in EMG activity was attributable the thixotropic characteristics of a stretched muscle. Mechanical changes in musculotendinous units may also be involved.

Previous studies have shown that there is no increased amount of EMG activity at progressively faster speeds during the prolonged activation of Vastus Medialis- a speed dependent reflex effect could not be identified.[25,22]

Pedaling at faster speeds resulted in reduced force output by the paretic limb. At faster pedaling speeds, the decrease in total work done by the paretic lower extremity was primarily accounted for by increase in the resistive component. Duration of agonist burst in absolute time was actually lessened at faster speeds because the effect of muscle activity in the Vastus Medialis, Rectus Femoris and Semimembranosus occurred at similar points in the crank cycle at progressively faster speeds.

Mechanical demands of faster pedaling speeds were the major contribution factor to the reduction in force output that occurred at faster pedaling speeds. The hypothesis implies that there is no harm to the nervous system when training individuals with spasticity to pedal at fast speeds.[23,22]

Increased pedaling speeds required earlier onsets of activity to reach a peak force at appropriate points in the cycle. In addition, at faster speeds and speed- dependent interaction forces (e.g. inertial forces such as corioli's forces) decreased in magnitude.

Given these mechanical alterations at higher speeds, it is believed that nervous system must develop strategies to deal with altered mechanics. Increased inappropriate activity would involve the exacerbation of EMG timing abnormality so that greater prolonged activity e.g. in Vastus Medialis may occur. Speed dependent EMG timing alteration so that peak force generation would be delayed. In the case of pedaling, an inability to generate earlier onset of muscle activity at faster speeds will result in peak pedal forces being generated at later, less appropriate regions of the crank cycle.[27]

Consclusion

The findings support the hupothesis that passive cycling at higher speeds has positive effects on gait outcomes of spastic paraplegic individuals, which leads to attainment of functional gait and hence, better quality of life in paraplegic patients.

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The Effect of Severity on the Isokinetic Strength in Knee Osteo Arthritis (OA)

Madan Shilpa

Senior Physiotherapist, Max Super Speciality Hospital, Saket, New Delhi

Abstract

To determine the relationship of torque measures of knee flexors to extensor muscles developed as a result of dysfunction and disease in knee Osteoarthritis (OA) and does the maximum peak torque measures change in patients with knee OA compared to healthy normal subjects.

Keywords: Isokinetic strength, concentric contraction, maximum peak torque, isokinetic dynamometer.

Introduction

Knee osteoarthritis is the leading cause of chronic disability in older persons[1]. Osteoarthritis commonly affects hands, feet, spine and large weight bearing joints such as hip and knees. Osteoarthritis is the second most common rheumatic problem and is most frequent joint disease with prevalence of 22% to 39% in India [4]. Prevalence of osteoarthritis in all joints is strikingly correlated with age. For subjects over the age of 45 years most population surveys showed that presence of radiographically determined OA of the knee varies between 14 and 30% and increases steadily with age[6]. Osteoarthritis of knee joint is characterized by localized tenderness over the joint and pain on passive or active motion Pain is frequently the first symptom and is often associated with swelling. Crepitus can often be detected and muscle atrophy is seen secondary to disuse [7]. Knee flexor muscle gaps are subject to hypotrophy and loss of strength, as well as the knee extensors in osteoarthritis of the knee joint. It has been documented that dynamic stability of the Knee joint depends on the appropriate strength ratio of quadriceps and hamstrings [9]. Purpose of this study is to determine the relationship of torque and torque ratio of knee flexors to extensors muscles developed as a result of dysfunction and disuse in osteoarthritis.

Statement of the Question

1) Does the maximum peak torque measures and maximum peak torque hamstring/ quadriceps ratio change in patients with knee osteoarthritis compared with normal control subjects.
2) Are there any differences between 2 patient groups when maximum peak torque and maximum peak torque hamstring/ quadriceps ratios were compared with each other.

Materials and Methods

30 patients with the symptomatic osteoarthritic knees (age 40 – 60 yrs) were divided into 3 groups.

Group1 – 10 Subjects exhibiting symptomatology and radiologic findings of knee OA.

Group2 – 10 Subjects having knee joint pain without any radiologic evidence of knee OA.

Group3 – 10 Healthy subjects.

Subjects in all the 3 groups performed concentric contractions of knee flexors and extensors that include 4 repetitions at 60 deg/ sec, 10 reps at 120 deg/sec and 20 reps at 180 deg/sec. Values of maximum peak torque of flexors and extensors and maximum peak torque hamstring to quadriceps ratio were recorded after each session.

Reprint requests: Madan Shilpa
Senior Physiotherapist
Max Super Speciality Hospital, Saket, New Delhi.

Results

Significant difference was found in maximum peak torque of flexors and extensors among 3 groups of subjects but no significant difference for ratio was observed among 3 groups. Values of maximum peak torque measures decreased with increasing speed of shortening and the hamstring to quadriceps values increased with increasing speed of shortening.

Conclusion

There is equal strength loss of both the muscles in patients with

Knee osteoarthritis, so hamstring strengthening exercises should be incorporated along with quadriceps strengthening exercise in rehabilitation plan of knee OA.

Hypothesis

There is equal strength loss of knee flexors and extensors in patients with knee osteoarthritis.

Methodology

Sample: A sample of convenience of 30 subjects with an age range from 40-60 years were recruited from Department of Orthopedics (Physiotherapy) , All India Institute of Medical Sciences. Subjects were referred by the Orthopedician. The eligibility criteria were checked and a written consent was taken from the subjects.

Inclusion criteria

1) Age group: 40-60 years
2) Symptomatic Osteoarthritic knees
3) Minimum available range of 0-90 degrees knee flexion

Exclusion criteria

1) Symptoms or signs of synovitis
2) Acute or chronic ligamentous insufficiency
3) Any history of knee surgery
4) Any history of recent injury to knee joint
5) Low back or hip joint disorders
6) Any systemic illness
7) Any history of doing prescribed exercises for knee osteoarthriti

Design

A comparative design was used in this study. Subjects were randomly assigned into three groups and were named as Group 1 ,Group 2 and Group3 . Demographic data was collected from the subjects who met the inclusion and exclusion criteria of the study. This included age, height weight, etc. Data was collected in one 45 minutes test session.

Instrumentation

1) Biodex System3 Pro Isokinetic Dynamometer
2) Weighing Scale
3) Stadiometer

Protocol

1) Subjects were diagnosed by the Orthopedician with the diagnosis of knee Osteoarthritis.Diagnosis was based on the Clinical criteria by Altman et al. Severity of osteoarthritis was measured by Kellgren and Lawrence criteria for radiological assessment.
2) The subjects diagnosed with knee osteoarthritis were invited to participate in the study. Those who fulfilled the inclusion criteria were asked to sign an informed consent form.
3) A Subjects were assigned into three groups as :

Group1: 10 subjects exhibiting symptomatology and radiologic findings of knee osteoarthritis.

Group 2: 10 subjects having knee joint pain without any radiologic evidence of knee osteoarthritis.

Group 3: 10 healthy subjects.

Procedure

All the testing was completed on Biodex System 3 Pro computer controlled isokinetic dynamometer, which was caliberated every 2 weekly by caliberation verification procedure as described in the operation manual of Biodex.

1) All the subjects were explained about the purpose, procedure and nature of the result.

2) Subjects were seated on the biodex chair and secured using upper crossing torso, pelvic, distal thigh stabilization straps.

3) An adjustable lever arm was attached to subject's leg by a resistance pad was put 1 inch proximal to the medial malleolus.

4) Subjects gripped the sides of chair and leaned back against the backrest, which was inclined posteriorly to an angle of 90 degrees above the horizontal.

5) The axis of rotation of dynamometer arm was positioned lateral to lateral femoral condyle.

6) Subject's anatomical position was caliberated by placing the joint in anatomical reference angle(0 degrees extension position was used as reference position in all subjects).

7) A range of motion of o degrees extension to 90 degrees flexion was targeted in all subjects.

8) With the limb positioned at 45 degrees of knee flexion, caliberation of limb weight was done to negate the gravity effect by the biodex software.

9) Subjects completed the warm up phase prior to actual testing. Warm up consisted of 3 consecutive trials for each speed of testing, one of which ws a maximal contraction.

10) Subjects performed concentric contraction of knee flexors and extensors at 3 preset speeds with 20 sec rest period between the sets.

11) Subjects performed 3 sets that included 4 repetitions at 60 degrees per second, 10 repetitions at 120 degrees per second and 20 repetitions at 180 degrees per second. The order of testing was from slower to faster speeds

12) Subjects were verbally encouraged to exert maximal efforts.

13) Data were collected for the maximum peak torque of flexors and extensors relative to body weight.

Data Analysis

Statistically the characteristics of the groups and the results were compared using One way ANOVA and Paired t tests.

Data were managed on an excel spreadsheet. SPSS (Statistical package for social science) software was used for data analysis.

One way ANOVA (Duncan's Mean Test) was used to analyze the difference in maximum peak torque of flexors and extensors and maximum peak torque hamstring to quadriceps ratio among 3 groups of respondents.

Paired t test was used to analyze the difference in maximum peak torque of flexors, extensors and maximum peak torque hamstring to quadriceps ratio among 3 speeds within the groups of respondents.

Result

In the present study, there was significant difference in Maximum peak torque of Flexors and Extensors among 3 Groups of respondents. No significant difference for Maximum peak torque (Hamstring / Quadriceps) Ratio was found among 3 Groups.When within group analysis was performed it was found that the value of maximum peak torque measures decreased with increasing speed of shortening and the Hamstring to Quadriceps sratio values increased with increasing speed of shortening.

Intergroup Analysis

Maximum peak torque / body weight of Extensors and Flexors and maximum peak torque hamstring to quadriceps ratio were compared among 3 groups of respondents using One way anova test.

Comparison of Maximum peak torque / body weight of Extensors among 3 Groups of respondents

At 60 deg/sec Maximum peak torque of extensors was significantly different between the groups. (F value = 56.99, $P<0.01$) Significant difference was found between groups 1 & 2, 2 & 3 and 1 & 3.

At 120 deg/sec Maximum peak torque of extensors was significantly different between the groups. (F value = 41.04, $P < 0.01$) Significant difference was found between groups 1 & 2, 2

& 3 and 1 & 3.

At 180 deg/sec Maximum peak torque of extensors was significantly different between the groups. (F value = 23.45, P < 0.01) Significant difference was found between groups 1 & 2, 2 & 3 and 1 & 3.

Comparison of Maximum peak torque / body weight of Flexors among 3 Groups of respondents

At 60 deg/sec Maximum peak torque of flexors was significantly different between the groups. (F value = 27.57, P<0.01) Significant difference was found between groups 1 & 3, 2 & 3 but not between 1 & 2.

At 120 deg/sec Maximum peak torque of flexors was significantly different between the groups. (F value = 16.14, P < 0.01) Significant difference was found between groups 1 & 3, 2 & 3 but not between 1 & 2.

At 180 deg/sec Maximum peak torque of flexors was significantly different between the groups. (F value = 6.86, P < 0.01) Significant difference was found between groups 1 & 3, 2 & 3 but not between 1 & 2.

Comparison of Maximum peak Torque (Hamstring / Quadriceps) Ratio among 3 Groups of respondents.

At 60 deg/sec Maximum peak torque (Hamstring / Quadriceps) Ratio values were not significantly different between the groups. (F value = 2.45, P = 0.10)

At 120 deg/sec Maximum peak torque (Hamstring / Quadriceps) Ratio values were not significantly different between the groups. (F value = 2.10, P = 0.14)

At 180 deg/sec Maximum peak torque (Hamstring / Quadriceps) Ratio values were not significantly different between the groups. (F value = 2.22, P = 0.12)

Within Group Analysis

Maximum Peak Torque / Body weight of extensors and flexors were compared among 3 speeds of testing within each group using paired-t test

Comparison of Maximum peak torque / body weight of extensors among 60 deg/sec, 120 deg/sec and 180 deg/sec in Group 1

Significant difference in maximum peak torque of extensors was found between 60 deg/sec and 120 deg/sec (t value = 2.87, P < 0.01).

Significant difference in maximum peak torque of extensors was found between 60 deg/sec and 180 deg/sec (t value = 5.66, P < 0.01).

Significant difference in maximum peak torque of extensors was found between 120 deg/sec and 180 deg/sec (t value = 4.39, P < 0.01).

Comparison of Maximum peak torque / body weight of flexors among 60 deg/sec, 120 deg/sec and 180 deg/sec in Group 1

Significant difference in maximum peak torque of flexors was found between 60 deg/sec and 120 deg/sec (t value = 2.32, P < 0.05).

Significant difference in maximum peak torque of flexors was found between 60 deg/sec and 180 deg/sec (t value = 3.64, P < 0.01).

Significant difference in maximum peak torque of flexors was found between 120 deg/sec and 180 deg/sec (t value = 2.93, P < 0.01).

Comparison of Maximum peak torque (Hamstring / Quadriceps) Ratio among 60 deg/sec, 120 deg/sec and 180 deg/sec in Group 1

No significant difference was found in Maximum peak torque (Hamstring/Quadriceps) Ratio between 60 deg/sec and 120 deg/sec (t value = 0.75, P = 0.47).

Significant difference was found in Maximum peak torque (Hamstring / Quadriceps) Ratio between 60 deg/sec and 180 deg/sec (t value = 2.17, P < 0.05).

Significant difference was found in Maximum peak torque (Hamstring / Quadriceps) Ratio between 120 deg/sec and 180 deg/sec (t value = 2.17, P < 0.05).

Comparison of Maximum peak torque / body weight of extensors among 60 deg/sec, 120 deg/sec and 180 deg/sec in Group 2

Significant difference in maximum peak torque of extensors was found between 60 deg/sec and 120 deg/sec (t value = 3.87, P < 0.01).

Significant difference in maximum peak torque of extensors was found between 60 deg/sec and 180 deg/sec (t value = 6.78, P < 0.01).

Significant difference in maximum peak torque of extensors was found between 120 deg/

sec and 180 deg/sec (t value = 8.97, $P < 0.01$).

Comparison of Maximum peak torque / body weight of flexors among 60 deg/sec, 120 deg/sec and 180 deg/sec in Group 2

No significant difference in maximum peak torque of flexors was found between 60 deg/sec and 120 deg/sec (t value = 0.98, $P = 0.35$).

Significant difference in maximum peak torque of flexors was found between 60 deg/sec and 180 deg/sec (t value = 2.97, $P < 0.01$).

Significant difference in maximum peak torque of flexors was found between 120 deg/sec and 180 deg/sec (t value = 2.60, $P < 0.05$).

Comparison of Maximum peak torque (Hamstring / Quadriceps) Ratio among 60 deg/sec, 120 deg/sec and 180 deg/sec in Group 2

Significant difference was found in Maximum peak torque (Hamstring / Quadriceps) Ratio between 60 deg/sec and 120 deg/sec (t value = 1.96, $P < 0.05$).

No significant difference was found in Maximum peak torque (Hamstring / Quadriceps) Ratio between 60 deg/sec and 180 deg/sec (t value = 1.63, $P = 0.13$).

No significant difference was found in Maximum peak torque (Hamstring / Quadriceps) Ratio between 120 deg/sec and 180 deg/sec (t value = 0.54, $P = 0.60$).

Comparison of Maximum peak torque / body weight of extensors among 60 deg/sec, 120 deg/sec and 180 deg/sec in Group 3

Significant difference in maximum peak torque of extensors was found between 60 deg/sec and 120 deg/sec (t value = 5.30, $P < 0.01$).

Significant difference in maximum peak torque of extensors was found between 60 deg/sec and 180 deg/sec (t value = 8.27, $P < 0.01$).

Significant difference in maximum peak torque of extensors was found between 120 deg/sec and 180 deg/sec (t value = 5.82, $P < 0.01$).

Comparison of Maximum peak torque / body weight of flexors among 60 deg/sec, 120 deg/sec and 180 deg/sec in Group 3

Significant difference in maximum peak torque of flexors was found between 60 deg/sec and 120 deg/sec (t value = 4.68, $P < 0.01$).

Significant difference in maximum peak torque of flexors was found between 60 deg/sec and 180 deg/sec (t value = 7.28, $P < 0.01$).

Significant difference in maximum peak torque of flexors was found between 120 deg/sec and 180 deg/sec (t value = 5.16, $P < 0.05$).

Comparison of Maximum peak torque (Hamstring / Quadriceps) Ratio among 60 deg/sec, 120 deg/sec and 180 deg/sec in Group 3

No significant difference was found in Maximum peak torque (Hamstring / Quadriceps) Ratio between 60 deg/sec and 120 deg/sec (t value = 1.64, $P = 0.13$).

Significant difference was found in Maximum peak torque (Hamstring / Quadriceps) Ratio between 60 deg/sec and 180 deg/sec (t value = 1.96, $P < 0.05$).

No significant difference was found in Maximum peak torque (Hamstring / Quadriceps) Ratio between 120 deg/sec and 180 deg/sec (t value = 0.97, $P = 0.91$).

For the Maximum peak torque measures, as the velocity of shortening increased, the value of concentric peak torque reduced. With the increase in the velocity of shortening an increase in value of maximum peak torque (Hamstring / Quadriceps) Ratio was observed.

Discussion

Knee stability is accomplished through three components osseous structures, ligamentous structures and the neuromuscular dynamic control system. The dynamic stabilizers of the knee are the muscles surrounding the joint. Muscle functions to provide movement dynamic joint stability and to control and absorb joint stress.

The quadriceps muscle is an important stabilizer of the knee joint and often exercise is designed to strengthen the quadriceps muscle.[7]

However, pain and swelling of the knee joint leads to restriction of range of motion and contractures of joint capsule and hamstrings. [54] Therefore, knee flexor muscle groups are subject to hypotrophy as well as knee extensors in knee osteoarthritis.

In this study investigation was done to determine the relationship of torque developed by knee flexors and extensors in the presence and absence of radiologic evidence of knee osteoarthritis. Measures of patients were also compared with healthy subjects to investigate muscle wasting in knee osteoarthritis.

To see the effect of severity on the Isokinetic strength in knee osteoarthritis. 3 groups of subjects were included in the study. Group 1 comprised of subjects with symptomatology and radiologic findings of knee osteoarthritis., more advanced cases of knee osteoarthritis. were included. Group 2 included subjects having knee joint pain without the radiologic evidence of knee osteoarthritis.. Group 3 comprised of healthy subjects of the same age group (40 – 60 years).

Lack of association between symptomatology and radiologic eveidence of OA was previously described by Cobbs et al in a study of Jaletan and Balci et al.[55]

The radiologic appearance may be normal if pathologic changes leading to clinical symptoms are sufficiently mild [56] and radiographic findings may lag behind patient's symptoms.

Stauff et al [49] cited in the study of Messier et al reported differences in Isometric strength of 55% to 70% in osteoarthritis. subjects compared to group of healthy adults.

Messier et al [49], in their studies confirmed that adults with osteoarthritis of knee have significantly less strength in both the dominant and non-dominant legs compared to age and gender matched adults without arthritis.

Chang, Pai et al [58], reported reduction in knee extension torques in knee osteoarthritis.. Lankhorst et al [50] reported that dynamic torque measurements had very little advantage over static tests.

Isokinetic exercise is an effective, safe and reliable alternative for knee osteoarthritis rehabilitation in elderly.

Concentric strength measures of knee flexors and extensors were used in accordance with the study by David et al[58], they reported test retest reliability of concentric mode of biodex.

Hamstring/quadriceps strength ratio was used based on the finding by Campbell et al (1982) who found that this ratio is better measure of knee function than peak torque. [36]

Klopffer et al[60] (1998) suggested the use of peak torque relative to body weight in establishing goals for rehabilitation of individuals with knee pathology.

Sitting position[48, 61] was chosen to measure maximum peak torque as supported by studies.

Slow to fast speed testing order was used in accordance with the study of Wilhite [48] et al (1992).

Tredinnick and Duncan[62] (1988) reported excellent reliability of concentric peak torque at 60 degrees/sec, 120 degrees/sec and 180 degrees/sec.

Trunk stabilization was used in accordance with a study by Hart et al.[35]

(1984) who found that adequate trunk stabilization leads to higher production of torque.

Michael et al[45] reported the importance of gravity correction of isokinetic peak torque during calculating knee flexor to extensor ratios.

Three submaximal including one maximal trials were selected in warm up on the basis of supporting literature. [63, 46]

Hard cushion end stop was used as suggested by Taylor et al[47] (1991).

Visual feed back of torque values was provided to subjects as supported by Broadie[63] et al (1991).

In this study significant difference was found in the maximum peak torque measures (Maximum peak torque/ body weight of flexors and extensors) of Group 1 ,2 and 3 .At all the speeds the extensor and flexor strength was reduced in subjects with advanced osteoarthritis as compared with healthy controls. In Group 1 subjects reduction of strength measures was more remarkable than subjects of Group 2.

There is significant isokinetic strength loss of both flexor and extensor muscle group progressing from Group 3 to Group 1, indicating that isokinetic strength loss progresses with disease progression, These findings are consistent with study by Jale tan et al (1995) they reported that there is isokinetic strength loss in patients with knee osteoarthritis.

Slemenda et al[59] (1998) reported reduced quadriceps strength relative to body weight in patients with knee osteoarthritis and contributed this to reflex inhibition of muscle contraction.

Dekkar et al cited in study of Giir et al[46] (2003) stated that muscle weakness is a mediating factor between negative affect and disability. They stated that negative affect enhances patient's tendency to avoid pain related activities, a low activity level induces muscle weakness and instability of joints.

Within group analysis in this study showed that as the speed of shortening increases the values of concentric torque decreases. Isokinetic muscle strength of knee flexors and extensors at 60 deg / sec was higher than the strength measures performed at 120 deg / sec and 180 deg / sec. These findings [55, 64, 66, 67, 69] are consistent with the findings reported in the literature.

Klofter and Grey [70] demonstrated increasing torque output by the hamstrings as the test velocities increased. They concluded that increasing velocity of knee extension may cause increased reaction of the stretch receptors in the hamstrings and facilitated torque production.

Thorstenson et al[71] (1977) stated that composition of fast twitch fibres and slow twitch fibres may effect torque output. If hamstring or quadriceps muscles contain a higher ratio of fast twitch fibres, increased torque production with increasing velocities may be expected.

The present study showed increased peak torque at decreasing velocity. Subjects (inactive, middle aged) in the study probably had a higher proportion of slow twitch fibres.

Kannus(1994)[72, 35] reported that for concentric contractions there is parallel decrease in maximal moment developed by muscles as speed increases. This is because of neuromuscular recruitment patterns that is both type I and type II fibres are activated together at lower speeds but as speed increases less number of type I fibres are recruited and eventually become inactive. At very high velocities smaller and smaller fiber populations are recruited.

The hamstring to quadriceps ratio is a measure of the relationship between strength of these two muscle groups.

In the present study , Within Group analysis showed that as the speed of shortening increases the value of torque increases.

These findings are in accordance with findings by Kannus et al [72], Nunne et al, indicating a possible decline in quadriceps activity.

Maximum peak torque hamstring to quadriceps ratio values were not significant between 3 groups of subjects at 60 deg / sec, 120 deg / sec and 180 deg / sec. The results indicate that there is hamstring as well as quadriceps weakness in subjects with knee osteoarthritis. These findings are consistent with findings by Brandt et al and Tan et al [55] (1995).

The findings of the present study are that i) as the disease progresses there is an increase in isokinetic strength loss of both flexors and extensors of the knee.ii) No significant difference in maximum peak torque hamstring to quadriceps ratio indicates strength loss of both muscle groups.

Clinical relevance

The results of this study showed that there is considerable loss of strength of flexors and extensors in patients with osteoarthritis as the severity of disease increases.There is no significant difference in maximum peak torque ratio indicating equal strength loss of both muscle groups.

So, hamstring muscle strengthening exercises are as important as quadriceps strengthening exercises and should be incorporated in the treatment plan of knee osteoarthritis.Isokinetic maximum peak torque loss of knee extensors and flexors was found in both patient groups, when measures were compared with healthy individuals.However, isokinetic strength ratios of hamstring to quadriceps muscles did not show a statistically significant difference between the groups.This may be related to equal strength loss of knee extensors and flexors sin patients with knee osteoarthritis rather than an ipsilateral muscle imbalance, which significantly proves the present hypothesis.

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

Dr.J.T. Mathew, Dr.R.K. Parasher, Dr. P.P. Mohanty, Dr. M. Pattnaik

Swamy Vivekanand National Institute of Rehabilitation Training and Research
Cuttack,Orissa-754 010

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

Reprint requests: J.T. Mathew
Head, Department of Physiotherapy
Ayushman College and Hospital
C –Sector, Shahpura, Bhopal 462 016 (M.P.)
Mobile Number: 9893387591

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.

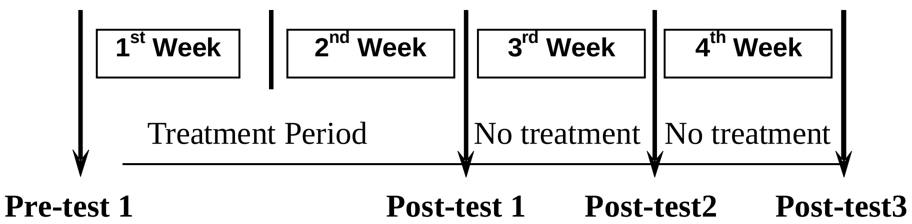
3) A measuring tape was used to measure the range of motion of cervical lateral flexion to the opposite side in centimeters. Investigators have measured side flexion to the opposite side previously also as an outcome measure for upper trapezius MF therapy. [32,26]

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.

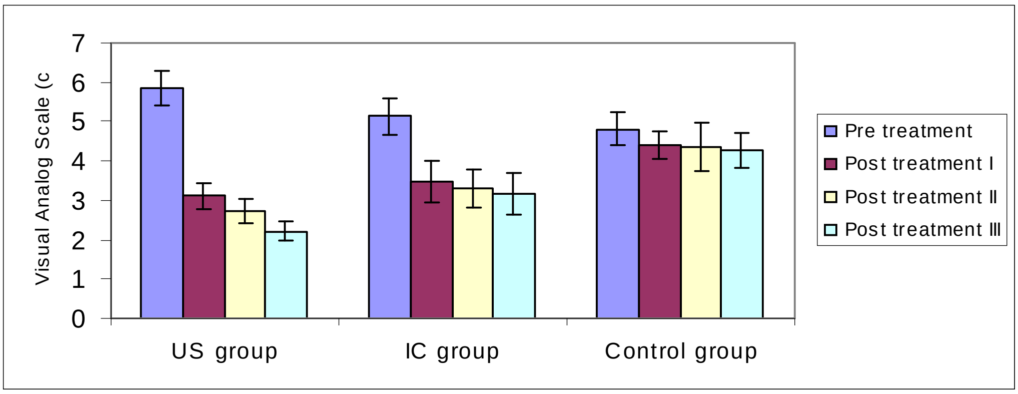
Both the Group1 and Group2 participants were given the above described passive stretching in addition to their respective treatment. All the Three groups were asked to do active ROM exercises as described in the protocol just after finishing the passive stretching. After finishing the active ROM all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

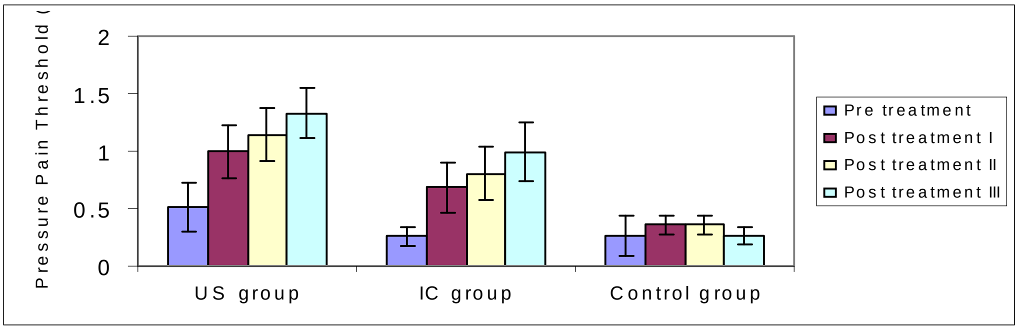
Visual Analog Scale Graph 1 - Visual Analogue Scale



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

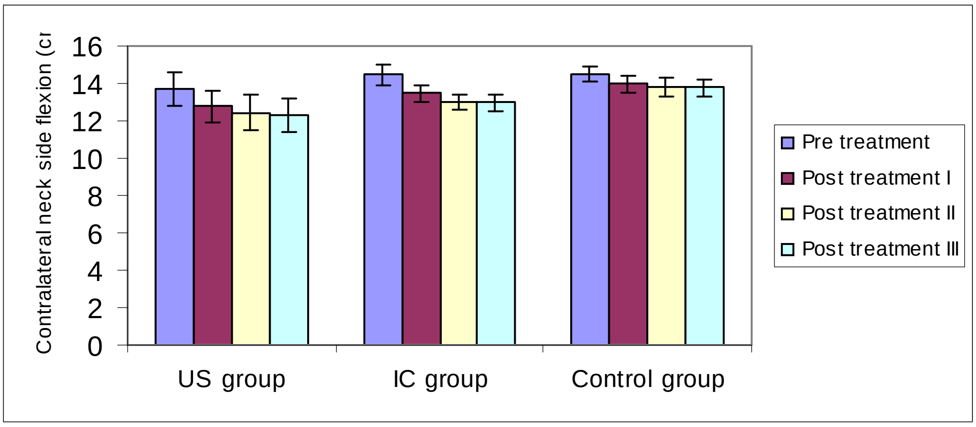
Graph 2 - Pressure Pain Threshold.



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, osteoarthitis 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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A Study on Efficacy of Pilates & Pilates & Mckenzie Exercises in Postural Low Back Pain- A Rehabilitative Protocol

***Niti Rajpal, **Manish Arora, ***Vivek Chauhan**

*Student, Masters in Physiotherapy (Sports) final year, Sardar Bhagwan Singh Institute, Dehradun, ** HOD, Sardar Bhagwan Singh Institute, Dehradun

*** Lecturer, MMIPR, Ambala

Introduction

Back is a mechanical structure that supports the individual throughout the life. Back pain is a huge public health issue affecting most of us at some times in our lives and causing enormous suffering. It continues to be a major cause of functional disability which almost affects between 60-80% of the population.

Although most of these low back pain episodes subside in 2-3 months, recurrence is common, shown to be as high as 85%. Studies indicates 2-3% of patients with LBP may proceed to suffer chronic disabling pain. Approximately 50% of all working people suffer back pain symptoms for atleast some of the time during any given year. Approximately 30% of people have had a back problem in the past 5 years that has been severe enough for them to seek professional help.

In a study conducted in rural north India, it was observed 23.09% patients reporting to out-patients clinic during 1 year had back pain. In this group, 67% had psychological issues, 57% were in blue collars jobs (heavy manual workers) 26% had to change/leave their profession and 38% did not enjoy their present jobs.

According to Nachemson, "low back pain occurs with about the same frequency in people with sedentary occupations as in those doing heavy labour, although the latter have the incidence of absence from work because they are unable to work with their complaint".[8]

Postural low back can be because of prolonged standing & sitting, poor posture, poor biomechanics, abnormal sleeping posture or sedentary lifestyle. Back pain particularly low back pain, is often caused by strained back muscles and ligaments as a result of improper lifting techniques or as a result of lifting an overly heavy loads, or as a result of sudden or awkward movement[4].

According to Michelle Schwahn, PT, in a healthy spine there is activation of deep core muscles in stabilization of the trunk before the body moves. This interaction between the deep core muscles and the nervous system plays a role in the proprioceptive feedback sent to the brain as we perform activities and undergo our normal activities.[6]

Number of strategies have been documented for treating low back pain as traction, hot/cold packs, short wave diathermy, interferential therapy, massage, TENS, ultrasound and stretching exercises etc. which provides improvement in pain and activity levels. [14] There is also strong evidence that general exercise programs results in reduced disability, reduced absenteeism and faster return to work. Classic trunk exercises involves both flexion & extension exercises activates abdominals & paraspinal muscles, increases inter-segmental stability (multifidus, transverse abdominis[13].Transversus abdominis acts as a girdle to flatten the abdominal wall and compress the abdominal viscera and stabilize linea alba. Its weakness leads to bulging of anterior abdominal wall, thereby causing hyperlordosis. Multifidus is also an important back extensor involved in providing stiffness for the lumbar spine.

Spinal stability is further increased with trunk flexor-extensor muscle co-activation which increases intra-abdominal pressure & produces abdominal spring force. [5]

Reprint requests: Niti Rajpal
Student, Masters in Physiotherapy
(Sports) final year, S.B.S. PG Institute, Balwala
Dehradun 248 161 (Uttaranchal)
Mob: 09927436020

The recent treatment regime for low back pain includes McKenzie exercises, Pilates regime, Williams flexion exercises, Cyriax, Pilates, Maitland mobilization& other manipulative therapies which promotes early activity& return to work.

Low back pain is common affliction whose specific cause and precise treatment are still a baffling to the medical profession. In the present study, the comparison between Pilates & McKenzie exercises is done to find out their effect on postural low back pain.

Pilates focuses on strengthening of core muscles of the back which affects the posture and provides support to the spine. It also improves strength and flexibility which helps to alleviate back pain. Pilates emphasizes on proper breathing and body awareness in addition to core conditioning. [9]

McKenzie defines postural syndrome as a mechanical deformation of postural origin causing pain of a strictly intermittent nature, which appears when the soft tissues surrounding the lumbar segments are placed under prolonged stress. McKenzie explains 3 syndromes-postural,dysfunction& derangement. The treatment for postural syndrome includes postural correction and re-education. [10]

Physiotherapists are pioneering investigations into the proposed mechanisms contributing to chronic and recurrent low back pain by evaluating the effects of specific exercise programme. Through highly skilled clinical practice and well designed research, physiotherapists are able to provide evidence for physiotherapy as a safe, low cost management approach.

Thus, this study is aimed to expand the work done by the studies conducted in western countries to identify the rehabilitation for low back pain in India and an effort to ensure best professional practice based on research evidence from scientific literature.

Operational Definitions

Pilates

It is an exercise program that works on strengthening the core muscles which affect posture and provide support and strength for the spine. It teaches body awareness, good posture & easy, graceful movement. Pilates improves flexibility, agility, & economy of motion. [9]

McKenzie

McKenzie defines postural syndrome as a mechanical deformation of postural origin causing pain of a strictly intermittent nature, which appears when the soft tissues surrounding the lumbar segments are placed under prolonged stress. This occurs when a person performs activities which keep the lumbar spine in a relatively static position (as in vaccuming, gardening) or when they maintain end positions for any length of time (as in prolonged sitting). [10]

Back performance scale score

It is a condition-specific performance measure of activity limitation for patients with back pain. It consist of the Sock test, Pick up test, Roll-up test, Fingertip to Floor test & Lift test. All the tests are scored on 4-point ordinary scales according to observed physical performance. The BPS is the sum of scores from all five tests and ranges from 0(no activity limitation) to 15(major activity limitation). [19, 20]

Sphygmomanometer

This was used to teach the correct activation of the Transversus abdominis muscle from the baseline pressure of 40mg of Hg (that is the pressure in the cell that fills the space behind the bag giving the patient an awareness only of it's presence), the correct drawing – in action causes a slight flattening of the lumbar spine, which registers as a pressure increase of approximately 10 mm of Hg. This pressure sensor provides both a measure and feedback system for the patient. [16]

Digital inclinometer

This inclinometer is a device used to measure angles from the horizontal reference[17]. The equipment used in the study is a hand held digital inclinometer from Chattanooga group, Inc. with ISO 9001 certification. The inclinometer was fixed on a wooden base for the purpose of measuring standing pelvic tilt angle.

Numeric pain scale

A 10 cm long non-sequential numeric rating scale with the range of scores from 0 (no pain) to 10 (worst pain) used for subjective evaluation of pain.

No pain ______________________ worst pain

0 1 2 3 4 5 6 7 8 9 10

Review of Literature

1. Keegan (1953) claimed that increased lumbar lordosis can increase the risk of chronic low back pain on the basis of study conducted towards the correlation between the lumbar lordosis and back ache.
2. Delarue. NC (1957) stated in "Poor posture: a social, industrial and medical problem" proposed that lumbar spine is associated with minimal normal anterior pelvic inclination and this results in increasing shortening and contracture of paraspinal muscles within the concavity of the lumbar curve. Canad.M.A.J.Aug 1957; 77: 252-256.
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12. Kay MA, Helewa A (1994) stated in "The effects of Maitland and McKenzie

techniques in the musculoskeletal management of low back pain: A pilot study" that the McKenzie group improved by 18 units on a pain visual analogue scale, the Maitland group deteriorated by 16 units. PhysTher.74.5.S: 59; 1994.

13. Goldby L (1995) stated in "A randomised controlled trial comparing the McKenzie method of mechanical diagnosis and therapy with a non-prescriptive exercise regime in the conservative treatment of chronic low back pain" that there were improvements in both groups, significant differences in McKenzie group in pain, and function. Proceedings 4th McKenzie Institute International Conference, England, September 1995.

14. Fowler B et al (1995) stated in "The therapeutic efficacy of McKenzie concept in the management of low back pain" that 27 patients treated with McKenzie had 74% made rapid recovery. Proceedings 12th International Congress World Confederation Physical Therapists, June, 1995, USA.

15. Gillan MG et al (1998) stated in "The natural history of trunk list, its associated disability and the influence of McKenzie management" that there was a significantly greater reduction of list in the McKenzie group.

16. "Philadelphia panel evidence-based clinical practice guidelines on selected rehabilitation interventions for low back pain". (2001) concluded that for sub-acute and chronic back pain there is good evidence to include certain specific exercises, including the McKenzie method. Physical Therapy 81; 1641-1674, 2001.

17. Petersen et al (2002) stated in "The effect of McKenzie therapy as compared with that of intensive strengthening training for the treatment of patients with subacute or chronic low back pain" that McKenzie therapy was more effective than the strengthening training. ARCT.Spine27.1702-1709.

18. Ludmila et al (2003) stated in "Effects of Physioball and Conventional Floor Exercises on Early Phase Adaptations in Back and Abdominal Core Stability and Balance in Women" that early adaptations in a short-term core exercise program using the physioball resulted in greater gains in torso balance and EMG neuronal activity in previously untrained women when compared to performing exercises on the floor. The Journal of Strength and Conditioning Research: pp. 721–725.

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20. Neil A. Segal MD (2004) stated in "The effect of Pilates training on flexibility & body composition: an observational study" that Pilates results in improved flexibility. Archives of Physical Medicine and Rehabilitation. Volume 85, Issue 12, December 2004, Pages 1977-1981.

21. Jri.P.Arokoski et al (2004) stated in" Activation of lumbar para-spinal and abdominal muscle during therapeutic exercises in low back pain patients" that patients with chronic low back pain when treated with active rehabilitation had no effect on abdominal muscles & back muscles activation. Archives of physical medicine and rehabilitation; 85: 823-832.

22. Joseph E Musculino (2004) stated in "Pilates & powerhouse-II" that Pilates is focused mainly towards the stabilizing contraction of the muscles of powerhouse. Journal of Bodywork and Movement Therapies. Volume 8, Issue 2, April 2004: 122-130.

23. Helen A Clare et al (2004) stated in "A systematic review of efficacy of McKenzie therapy for spinal pain" that patients with low back pain treated with McKenzie therapy resulted in a greater decrease in pain and disability in the short term than do other standard therapies.Australian Journal of Physiotherapy 50: 209–216.

24. Gregory J Lehman et al (2005) stated in "Trunk muscle activity during bridging exercises on and off a swissball" that swiss ball is capable of influencing trunk muscle activity in the rectus abdominis and external oblique musculature during prone bridge exercises.Chiropractic & Osteopathy 2005, 13: 14doi: 10.1186/1746-1340-13-14.

25. Lee Herrington et al(2005) stated in" The influence of Pilates training on the ability to contract the transversus abdominis muscle in asymptomatic individual" that Pilates trained subjects could contract transversus abdominis & maintain better lumbo-pevic control. Journal of Bodywork and Movement Therapies. Volume 9, Issue 1, January 2005: 52-57.

26. Jill V Quinn et al (2005) stated in "The influence of Pilates- based mat exercises on chronic low back pain" that Pilates is an effective method for reducing muscle activity in para-spinal muscles in those who experience chronic low back pain. Journal of American college of sports medicine, 2005, Vol.37.

27. Valerie Gladwell et al (2006) stated in" Does a program of Pilates improve chronic non-specific low back pain?" that Pilates is effective in treating non-specific low back pain and it improves general health, pain level, flexibility and proprioception in individuals with chronic low back pain. J Sport Rehabil. 2006,15: 338-350.

28. Slade SC et al (2006) stated in "Trunk strengthening exercises for chronic low back pain: a systematic review" that trunk strengthening compared with aerobic or McKenzie exercises showed no benefit on strengthening. J Manipulative Physio Ther. 2006 Feb; 29(2): 163-73.

29. S. Donzelli et al (2006) stated in "Two different techniques n the rehabilitation treatment of low back pain: a randomized controlled trial" that Pilates technique is more effective than back school method in the treatment of low back pain. Eura Medico Phys 2006; 42: 205-210.

30. Rochend Rydeard et al (2006) stated in "Pilates based approach on subjects with non-specific low back pain" that Pilates reported significant decrease in low back pain and disability. Journal of Orthopaedic and Sports Physical Therapy; 36(7): 472-484.

31. Marshall PW et al (2006) stated in "Evaluation of functional and neuromuscular changes after exercise rehabilitation for back pain using swiss ball: a pilot study" that swiss ball can be used in the rehabilitation context for patients with low back pain. Journal of manipulative physiological therapy 2006: 550-560.

32. J Klaber Moffett et al (2006) stated in "The randomized trial of two physiotherapy interventions for primary care neck and back pain patients: McKenzie vs brief physiotherapy pain management" that McKenzie was more effective than the other physiotherapy pain management. Rheumatology 2006 45(12): 1514-1521.

33. Brian M Busanich et al (2006) stated in "Does McKenzie therapy improves outcomes for back pain?" that McKenzie therapy results in decrease in pain & disability for low back pain patients compared with other standard treatments, such as NSAIDS, back massage with back care advice, strength training with therapist supervision and spinal mobilization. Aust J Physiother. 2004; 50: 209-216.

34. Betul Sekendiz et al (2006) stated in "The effect of Pilates exercise on trunk strength, endurance & flexibility in sedentary adult females" that there was a positive effect of Pilates mat exercises on abdominal and lower back muscular strength, abdominal muscular endurance and posterior trunk flexibility in sedentary adult females. Journal of body work and movement therapies, (2006): 318-326.

Research Design and Methodology

Nature of study

It is an experimental study intended to see the efficacy of Pilates & McKenzie exercises on postural low back pain.

Research setting

Study was performed in the out-patient department of Sardar Bhagwan Singh Post Graduate Institute of Biomedical Sciences and Research, Balawala, Dehradun.

Ethical approval and consent

After selecting the sample, the methodology and procedure were explained and a written consent was obtained from all subjects prior to the study.

Population of the study

Population of 40 female subjects of age group 20-30 years were assessed and selected.

Sample size

A sample of 40 subjects who fulfill the selection criteria, were included in the study, out of which 32 subjects completed the 30 days protocol. 17 subjects were from Pilates Group and the rest of 15 subjects were studied in McKenzie Group.

Method of assigning samples

40 subjects were selected on the basis of assessment and who met the inclusion criteria. The subjects were then randomly allocated into both groups, Pilates Group (n=20) and McKenzie Group (n=20).

Inclusion criteria

* Patients with postural low back pain for 3 months.
* Female subjects between the age group 20-30 years.
* Subjects with the standing pelvic tilt angle of 9^{o} or more.
* Subjects with reduced abdominal muscle strength.

Exclusion criteria

* Subjects having sciatica or any neurological deficit.
* Subjects having soft tissue injuries.
* Subjects with spinal fractures.
* Subjects with disc prolapse.
* Back pain due to structural deformity, infection, tumour.

Variables

Dependent variable

* Back performance scale score.
* Core muscle strength (Sphygmomanometer).
* Digital inclinometer.
* Numerical pain scale. Independent variable
* Pilates regime.
* McKenzie exercises.

Instrumentation

· Digital inclinometer
· Sphygmomanometer
· Plinth
· Mat
· Swiss ball

Protocol

After satisfying the inclusion and exclusion criteria and receiving their informed consent, each subject was randomly assigned to both groups.

Pilates Group (n=17) (10 reps, 10 seconds hold x 30 days)

McKenzie Group (3 reps,15 - 20 daily

B (n=15)x 30 days)

Procedure

During the initial session, assessment of core muscle strength and posture was done. Recordings were done on the 0 day before the treatment, 15^{th} day and 30^{th} day after the treatment protocol.

Demographic data was collected from each subject included age, gender, occupation etc. Subjective assessment was done to rule out for the presence of any symptoms like history of trauma, muscle weakness, radiating pain, surgical or any medical illness.

Measurements

Core muscle strength

Core muscle strength was measured using sphygmomanometer. The subject were made to lie in crook lying on a firm surface and were taught the contraction of Transversus abdominis by holding the breath during exhalation and moving the belly upwards and inwards and holds for 10 seconds. The flicker was felt infero-medial to the ASIS. Once the subject mastered this procedure, the sphygmomanometer cuff was placed beneath the back at the level of umbilicus. The cuff was inflated upto 40mm of Hg & the point at which the subject feels the cuff is noted down. The subject then contracts the muscle by holding the breath during exhalation. If the deflection rises for more than 10mm of Hg, this indicates that the core muscle strength is normal for that individual and if less than 10mm of Hg, the core muscle strength is weak. [16]

Back performance scale score

The patient was asked to perform the following tests:-Sock test, Pick up test, Roll-up test, Fingertip to Floor test & Lift test. Each test was performed three times and the mean value was recorded. And later on the sum of scores was done and recorded. [19, 20]

Standing pelvic tilt angle

It was measured using the digital inclinometer and a base to determine the angle formed by the horizontal plane and a line drawn between the ASIS and PSIS.

Each measurement was taken 3 times, allowing the subject 1 minute rest in between and the mean value was used as a data for the main analysis.

The subjects were instructed to stand barefooted on a sheet of paper with feet shoulder wide apart and weight evenly distributed. A tracing was made of the subject's feet so that all measurements were made with the subject in the same standing position. Now the ASISs were exposed, palpated and marked with a black dot over the apices. With the similar procedure, dots were marked over the centre of the PSISs. Once the dots were marked, the arms of the inclinometer base were placed on the already marked ASIS and PSIS on each side separately by placing on the ilium and recording was done directly from the inclinometer.[11,12]

Numeric pain scale

A 10 cm long line was drawn on a paper with 1(no pain) to 10 (worst pain) markings on it and the subject was instructed to mark a point at which he feels the pain. The readings were recorded on the day 0, day 15th and 30th day.

Interventions

After recording pretreatment values for the dependent variable, the treatment was assigned according to group allocation. 30 subjects completed the set protocol, 17 subjects in Pilates group and 15 in McKenzie group.

Pilates Group

In this the group (n=17) the subjects were given Pilates exercises for one month. The exercises were done for 10 times with 10 seconds hold in between daily. [21, 22, 23]

This includes:-

* The subjects were made to lie in crook lying with hip and knee flexed .In this position, the lumbar spine is neither arched up nor flattened against the floor, but is aligned normally with a small gap between the floor and the back. The subjects were asked to breathe in deeply and relax all the stomach muscles. While breathing out, the subject draws the lower abdomen inwards as if the umbilicus goes backwards and upwards.The contraction was held for 10 seconds and then relaxed. This exercise was done for 10 times daily for 10 days.
* The subjects were made to lie in quadrapod / 4-point kneeling position and were allowed to do the same contractions for 10 times daily for next 10 days.
* The subjects were made to sit on an exercise ball with both hands over the pelvis and were made to perform the same contractions and along with that, were made to extend their leg simultaneously. This exercise was performed for 10 times daily for the next 10 days[23].

McKenzie Group

In this group, the subjects were taught postural correction and re-education. This includes:-

Correction of the sitting posture

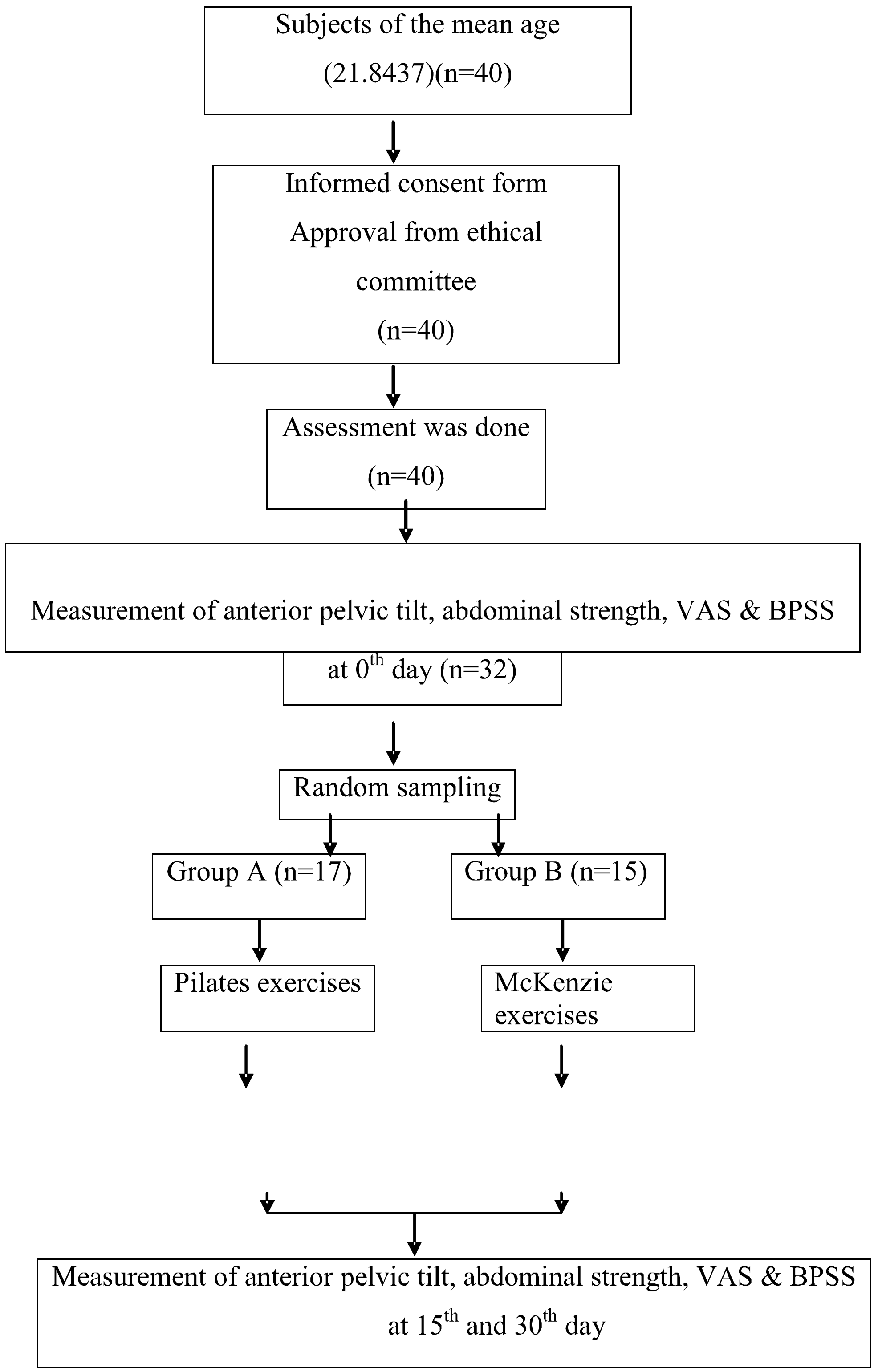
The subjects were explained that as a person sits, his spine sooner or later takes a relaxed posture and the lumbar spine moves into a fully flexed position that places stress over the various ligamentous structures. This position is painful if maintained for longer period.

The subjects were taught how to obtain and maintain the sitting posture for longer periods.

1. To obtain the correct sitting posture- This includes 'slouch-overcorrect' procedure.

   The subjects were made to sit slouched on a backless chair or stool, allowing the lumbar

Protocol



spine to rest on the ligaments in the fully flexed position and permit head and chin to protrude. Then, slowly moved into the erect sitting posture with the lordosis at its maximum and the head held directly over the spine with the chin pulled up. This sequence was repeated for 3 times daily, 15-20 times at each session.

Once they had mastered this procedure, they were advise to follow this procedure whenever they feel pain and maintain the position.

2. To maintain the correct sitting position- The subjects were taught about maintaining the lumbar lordosis by 2 ways-

- Actively by conscious control of the lordosis, when sitting on a chair without back rest.
- Passively by using the lumbar support, when sitting on a seat with a back rest. The lumbar roll was used to hold the lumbar spine in a good position while prolonged sitting. The roll was placed at or just above the belt line (area of L3 and L4 vertebrae).

This procedure was repeated for 3 times daily, 15-20 times at each session.

Correction of standing posture

The subjects were made to stand and moving the lower part of the spine backwards by tightening the abdominal muscles and tilting the pelvis posteriorly, while at the same time moving the upper spine forwards and raising the chest.

This procedure was repeated for 3 times daily, 15-20 times at each session.

Outcome measures

For both the groups the assessment of standing pelvic tilt angle, Core muscle strength, VAS, Back performance scale score was done initially before starting the treatment .i.e. 0 day, 15th day and 30th day. The final measurement was taken following the 30th day treatment protocol.

Reliability

Standard pelvic tilt angle

1. The palpation of ASIS and PSIS was given by Derek Field (1997) in "Anatomy: palpation and surface markings".[11]
2. The procedure of markings of bony landmarks and measurement of standing pelvic tilt angle by pelvic inclinometer was used by-

- Freburger. JK & Riddle. DL (1999) in their study "Measurement of sacro-illiac joint dysfunction: a multitester intertester reliability study".[12]
- Walker. ML et al (1987) in their study "Relationship between lumbar lordosis, pelvic tilt and abdominal muscle performance".[18]

Core strength

1. The measurement of core strength by using sphygmomanometer was given by Lance T Twomey & James R Taylor (1994) in "Physical Therapy of low back"[16].

Back performance scale score

1. This outcome scale was given by Mirjam Myklebust et al (2004) in "Back performance scale scores in people without back pain: Normative data".[19]
2. The reliability of back performance scale score was given by Magnussen L, Strand LI, Lygren H (2004) in "Reliability and validity of the back performance scale: Observing activity limitation in patients with back pain".[20]

Visual analogue scale (VAS)

1. The validity of scale was given by Price D, McGrath P, Rafii A, Buckingham B (1983) in "The validation of visual analogue scales as ratio scale measures for chronic and experimental pain".[30]
2. The quantitative measure of pain was given by Zusman M (1986) in" The absolute visual analogue scale (AVAS) as a measure of pain intensity".[31]

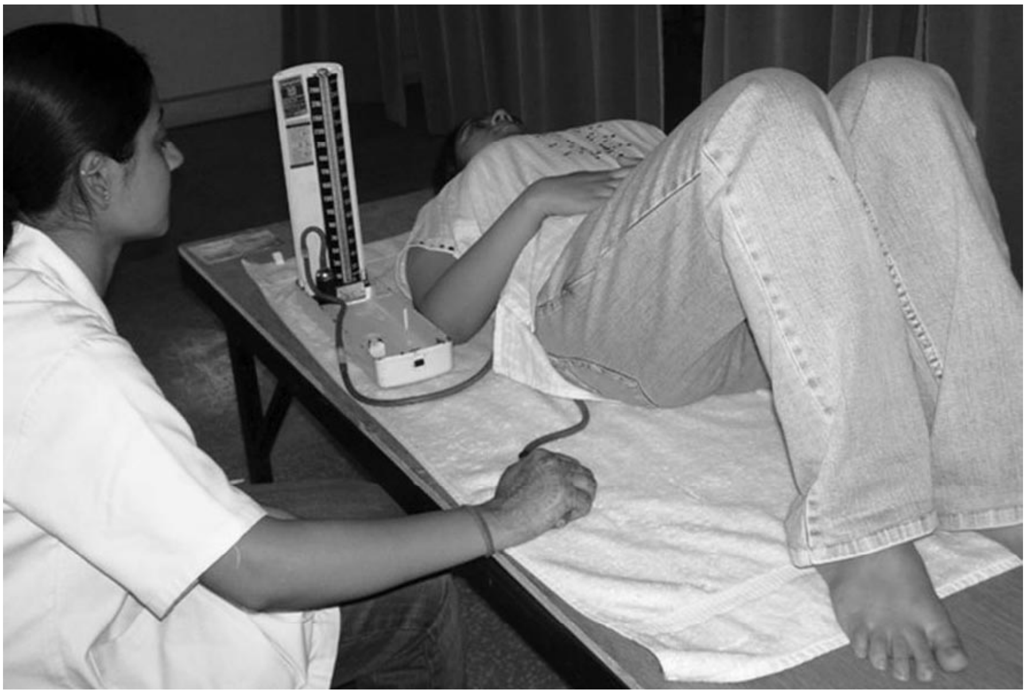
Instrumental reliability

Reliability of digital inclinometer

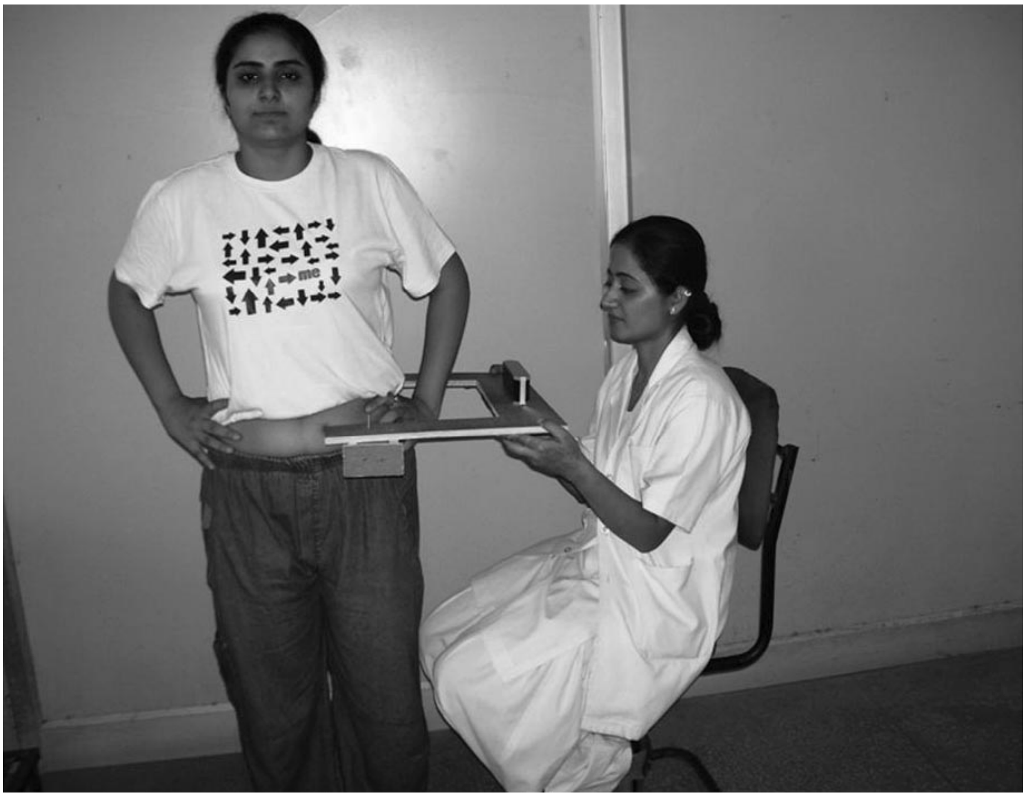
The standard pelvic tilt was calculated by using hand held digital inclinometer from Chattanooga group, Inc. with ISO 9001 certification.

Reliability of sphygmomanometer

Prolix sphygmomanometer, IS: 3390, CM/L-8262373.

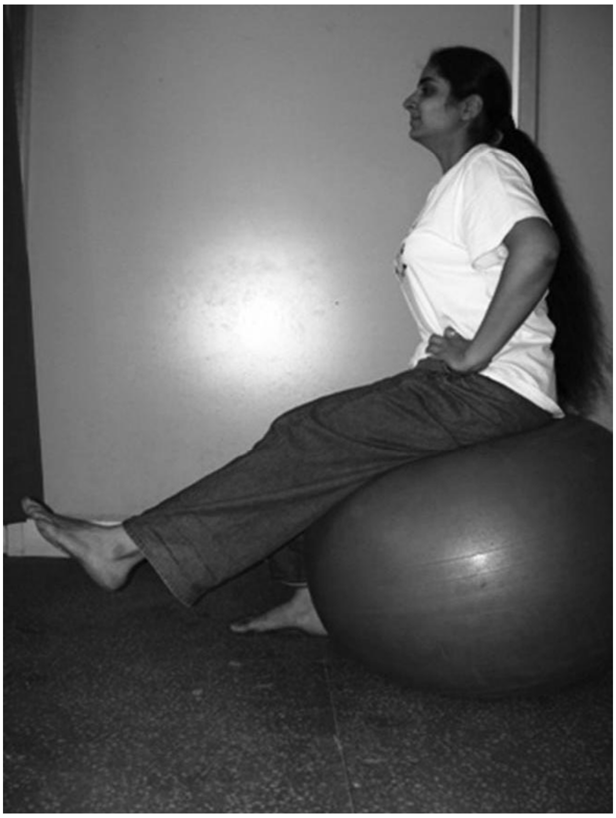


Measurement of core strength



Measurement of standing pelvic tilt angle

Pilates exercise on a swiss ball- starting position



Pilates exercise on a swiss ball- alternate leg raise

Pilates exercise in quadrapod position

Data Analysis

The data were analyzed using statistical tests, which were performed using SPSS 10.0 software package.

- Paired t-test was used to analyse the dependent variable .i.e. standing pelvic tilt angle, core strength, back performance scale score and VAS for within the group A and B.
- Unpaired t-test was used for analyzing the dependent variable .i.e. standing pelvic tilt angle, core strength, back performance scale score and VAS for between the group A and B. A 0.05 level of significance was used for all comparisons.

Results

Group A included 17 subjects with the mean age of 22.05 and Group B included 15 subjects with the mean age of 21.6.

Standing pelvic tilt angle (SPTA)

Between the groups

The analysis between Pilates group and McKenzie group were done using unpaired t-test for 0 day, 15th day and 30th day. The result showed no significant differences between the groups. (pe”0.05).

Table-1

Comparison of mean standing pelvic tilt angle at 0 day, 15th day and 30th day between Pilates group and McKenzie group.

GROUP	N	0-15 day	15-30 day	0- 30 day
PILATES	17	0.882± 0.485	0.823± 0.727	1.822± 0.927
MCKENZIE	15	0.666± O.617	0.933± 0.883	1.600± 0.736
t-value		1.106	0.385	0.944
Significance	NS	0.278	0.703	0.352

S= Significant ($P \leq 0.05$)

NS= Not significant ($P \geq 0.05$)

The result showed no significant differences between the groups. ($p \geq 0.05$)

Core strength

Between the groups

The analysis between Pilates group and McKenzie group was done using unpaired t-test for 0 day, 15th day and 30th day. The result showed significant differences in Pilates group as compared to McKenzie group (pd"0.05)

Table-2

Comparison of mean core strength at 0 day, 15th day and 30th day between Pilates group and McKenzie group.

GROUP	N	0-15 day	15-30 day	0-30 day
PILATES	17	3.529±1.662	3.705±1.686	7.294± 2.257
MCKENZIE	15	0.333±0.487	0.533±0.516	0.866±0.743
t-value		7.165	6.989	10.519
Significance	S	0.000	0.000	0.000

S=Significant ($P \leq 0.05$)

NS=Not significant ($P \geq 0.05$)

The result showed significant differences in Pilates group as compared to McKenzie group ($p \leq 0.05$).

Back performance scale score

Between the groups

The analysis between Pilates group and McKenzie group was done using unpaired t-test for 0 day, 15th day and 30th day. The result showed no significant differences between the groups. (pe"0.05)

Table-3

Comparison of mean back performance scale score at 0 day, 15th day and 30th day between group A and group B.

GROUP	N	0-15 day	15-30 day	0-30 day
PILATES	17	0.882± 0.600	0.941± 0.658	1.941± 0.555
MCKENZIE	15	0.866± 0.639	0.666± 0.487	1.533± 0.639
t-value		0.072	1.324	1.930
Significance	NS	0.943	0.195	0.063

S= Significant ($P \leq 0.05$)

NS= Not significant ($P \geq 0.05$)

The result showed no significant differences between the groups. ($p \leq 0.05$)

VAS

Between the groups

The analysis between Pilates group and McKenzie group was done using unpaired t-test for 0 day, 15th day and 30th day. The result showed significant differences in Pilates group as compared to McKenzie group ($p \leq 0.05$)

Table-4

Comparison of mean VAS at 0 day, 15th day and 30th day between Pilates group and McKenzie group.

GROUP	N	0- 15 day	15-30 day	0-30 day
PILATES	17	1.352± 0.606	2.000± 0.707	3.352± 0.931
MCKENZIE	15	0.533±0.516	1.466± 0.990	2.000± 1.000
t-value		4.087	1.769	3.962
Significance	S	0.000	0.087	0.000

S=Significant ($P \leq 0.05$)a

NS=Not significant ($P \geq 0.05$)

The result showed significant differences in Pilates group as compared to McKenzie group ($p \leq 0.05$).

Standing pelvic tilt angle (SPTA)

Within the group

Group A: The analysis within Pilates group was done using paired t-test for 0 vs 15th day, 15th vs 30th day and 0 vs 30th day. The results revealed no significant improvement over time within Pilates group. 'p' value was found not significant ($p \geq 0.05$).

Table-5

Comparison of the mean standing pelvic tilt angle at 0-15 day, 15-30 day and 0-30 day within the Pilates group.

SESSIONS	N	Mean± SD	t- value	SIGNIFICANCE
O-15 DAY 15-30 DAY	17 17	0.882± 0.485 0.823± 0.727	0.251	0.805
15-30 DAY 0-30 DAY	17 17	0.823± 0.727 1.882± 0.927	4.123	0.001
0-30 DAY 0-15 DAY	17 17	1.882± 0.927 0.882± 0.485	7.856	0.000

S= Significant ($P \leq 0.05$)

NS= Not significant ($P \geq 0.05$)

The results revealed no significant improvement over time within Pilates group.

Group B: The analysis within McKenzie group was done using paired t-test for 0 vs 15th day, 15th vs 30th day and 0 vs 30th day. The results revealed little significant improvement over time within McKenzie group. 'p' value was found not significant ($p \geq 0.05$).

Table- 6

Comparison of the mean standing pelvic tilt angle at 0-15 day, 15-30 day and 0-30 day within the McKenzie group.

SESSIONS	N	Mean± SD	t-value	SIGNIFICANCE
O – 15 DAY 15-30 DAY	15 15	0.666± 0.617 0.933± 0.883	0.774	0.452
15-30 DAY 0-30 DAY	15 15	0.933± 0.883 1.60± 0.736	4.183	0.001
0-30 DAY 0-15 DAY	15 15	1.60± 0.736 0.666± 0.617	4.090	0.001

S=Significant (P ≤ d" 0.05)

NS=Not significant (P ≥ 0.05)

The results revealed little significant improvement over time within McKenzie group.

Core strength

Within the group

Group A: The analysis within Pilates group was done using paired t-test for 0 vs 15th day, 15th vs 30th day and 0 vs 30th day. More effect was seen between 15th – 30th day as compared to 0- 15th day, therefore improved strength was seen in 0-30th day. The results revealed significant improvement over time within Pilates group. 'p' value was found to be significant ($p \leq 0.05$).

Table- 7

Comparison of the core strength at 0-15 day, 15-30 day and 0-30 day within the Pilates group.

SESSIONS	N	Mean± SD	t-value	SIGNIFICANCE
O – 15 DAY 15-30 DAY	15 15	0.666± 0.617 0.933± 0.883	0.774	0.452
15-30 DAY 0-30 DAY	15 15	0.933± 0.883 1.60± 0.736	4.183	0.001
0-30 DAY 0-15 DAY	15 15	1.60± 0.736 0.666± 0.617	4.090	0.001

S=Significant (P ≤ 0.05)

NS=Not significant (P ≥ 0.05)

The results revealed significant improvement over time within Pilates group. 'p' value was found to be significant ($p \leq 0.05$).

Group B: The analysis within McKenzie group was done using paired t-test for 0 vs 15th day, 15th vs 30th day and 0 vs 30th day. The results revealed no significant improvement over time within McKenzie group. 'p' value was found not significant ($p \geq 0.05$).

Table- 8

Comparison of the core strength at 0-15 day, 15-30 day and 0-30 day within the McKenzie group.

SESSIONS	N	Mean± SD	t- value	SIGNIFICANCE
O – 15 DAY 15-30 DAY	15 15	0.333± 0.487 0.533± 0.516	1.146	0.271
15-30 DAY 0-30 DAY	15 15	0.533± 0.516 0.866± 0.743	2.646	0.019
0-30 DAY 0-15 DAY	15 15	0.866± 0.743 0.333± 0.487	4.000	0.001

S=Significant ($P \leq 0.05$)

NS=Not significant ($P \geq 0.05$)

The results revealed no significant improvement over time within McKenzie group. 'p' value was found not significant ($p \geq 0.05$).

Back performance scale score

Within the group

Group A: The analysis within Pilates group was done using paired t-test for 0 vs 15th day, 15th vs 30th day and 0 vs 30th day. The results revealed no significant improvement over time within Pilates group. 'p' value was found not significant ($p \geq 0.05$).

Table- 9

Comparison of the back performance scale score at 0-15 day, 15-30 day and 0-30 day within the Pilates group.

SESSIONS	N	Mean± SD	T value	SIGNIFICANCE
O – 15 DAY 15-30 DAY	17 17	0.882± 0.600 0.941± 0.658	0.212	0.835
15-30 DAY 0-30 DAY	17 17	0.941± 0.658 1.941± 0.555	5.215	0.000
0-30 DAY 0-15 DAY	17 17	1.941± 0.555 0.882± 0.600	6.628	0.000

S=Significant ($P \leq 0.05$)

NS=Not significant ($P \geq 0.05$)

The results revealed no significant improvement over time within Pilates group. 'p' value was found not significant ($p \geq 0.05$).

Group B: The analysis within McKenzie group was done using paired t-test for 0 vs 15th day, 15th vs 30th day and 0 vs 30th day. The results revealed no significant improvement over time within McKenzie group. 'p' value was found not significant ($p \geq 0.05$).

Table-10

Comparison of the back performance scale score at 0-15 day, 15-30 day and 0- 30 day within the McKenzie group.

SESSIONS	N	Mean± SD	T value	SIGNIFICANCE
O – 15 DAY 15-30 DAY	15 15	0.866± 0.639 0.666± 0.487	0.823	0.424
15-30 DAY 0-30 DAY	15 15	0.666± 0.487 1.533± 0.639	5.245	0.000
0-30 DAY 0-15 DAY	15 15	0.666± 0.487 0.866± 0.639	5.292	0.000

S=Significant ($P \leq 0.05$)

NS=Not significant ($P \geq 0.05$)

The results revealed no significant improvement over time within McKenzie group. 'p' value was found not significant ($p \geq 0.05$).

VAS

Within the group

Group A: The analysis within Pilates group was done using paired t-test for 0 vs 15th day, 15th vs 30th day and 0 vs 30th day. More improvement was seen in 0-15 day as compared to 15-30 day, therefore more improvement was seen on 0-30 day. The results revealed significant improvement over time within Pilates group. 'p' value was found to be significant ($p \leq 0.05$).

Table-11

Comparison of the VAS at 0-15 day, 15-30 day and 0- 30 day within the Pilates group.

SESSIONS	N	Mean± SD	T value	SIGNIFICANCE
O – 15 DAY 15-30 DAY	17 17	1.352± 0.606 2.000± 0.707	2.864	0.011
15-30 DAY 0-30 DAY	17 17	2.000± 0.707 3.352± 0.931	9.200	0.000
0-30 DAY 0-15 DAY	17 17	3.352± 0.931 1.352± 0.606	11.662	0.000

S= Significant ($P \leq 0.05$)

NS= Not significant($P \geq 0.05$)

The results revealed significant improvement over time within Pilates group. 'p' value was found to be significant ($p \leq 0.05$).

Group B: The analysis within McKenzie group was done using paired t-test for 0 vs 15th day, 15th vs 30th day and 0 vs 30th day. The results revealed no significant improvement over time within McKenzie group. 'p' value was found not significant ($p \geq 0.05$).

Table-12

Comparison of the VAS at 0-15 day, 15-30 day and 0- 30 day within the McKenzie group.

SESSIONS	N	Mean± SD	T value	SIGNIFICANCE
O – 15 DAY 15-30 DAY	15 15	0.533± 0.516 1.466± 0.990	2.956	0.010
15-30 DAY 0-30 DAY	15 15	1.466± 0.990 2.000± 1.000	4.000	0.001
0-30 DAY 0-15 DAY	15 15	0.533± 0.516 2.000± 1.000	5.735	0.000

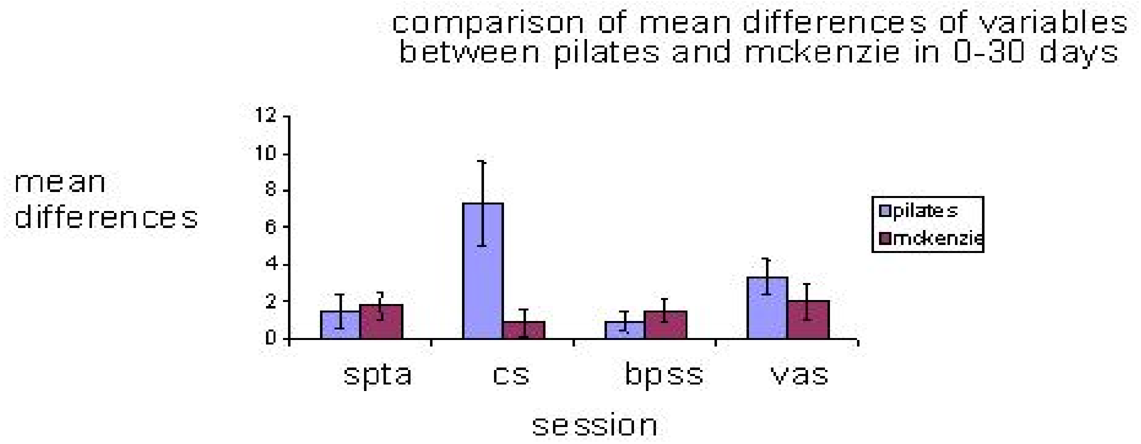
S=Significant ($P \leq 0.05$)

NS=Not significant ($P \geq 0.05$)

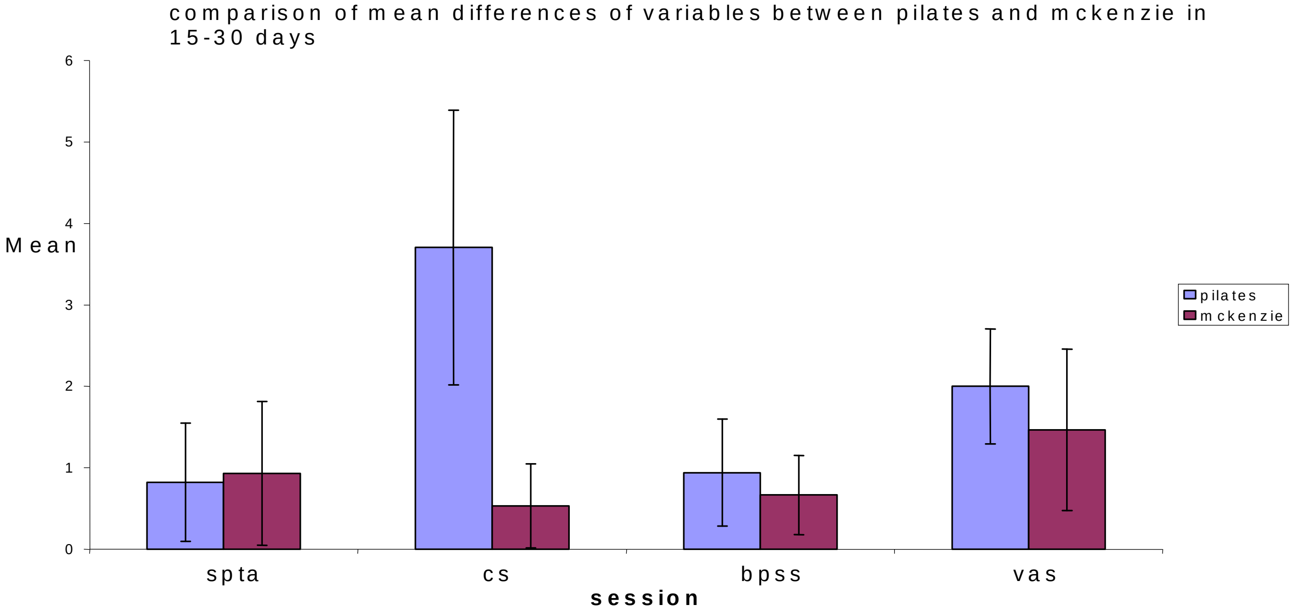
The results revealed no significant improvement over time within McKenzie group.

'p' value was found not significant ($p \geq 0.05$).

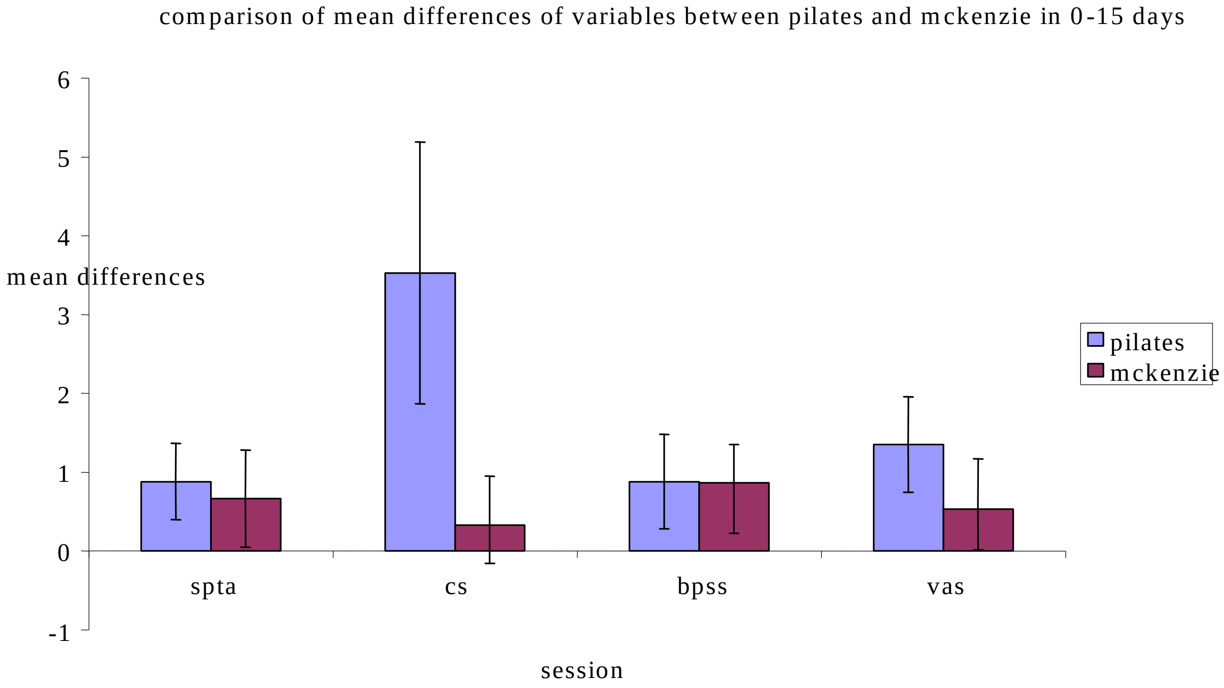
The analysis therefore revealed that Pilates regime influenced core strength and VAS as compared to standing pelvic tilt angle and BPSS during the study period.



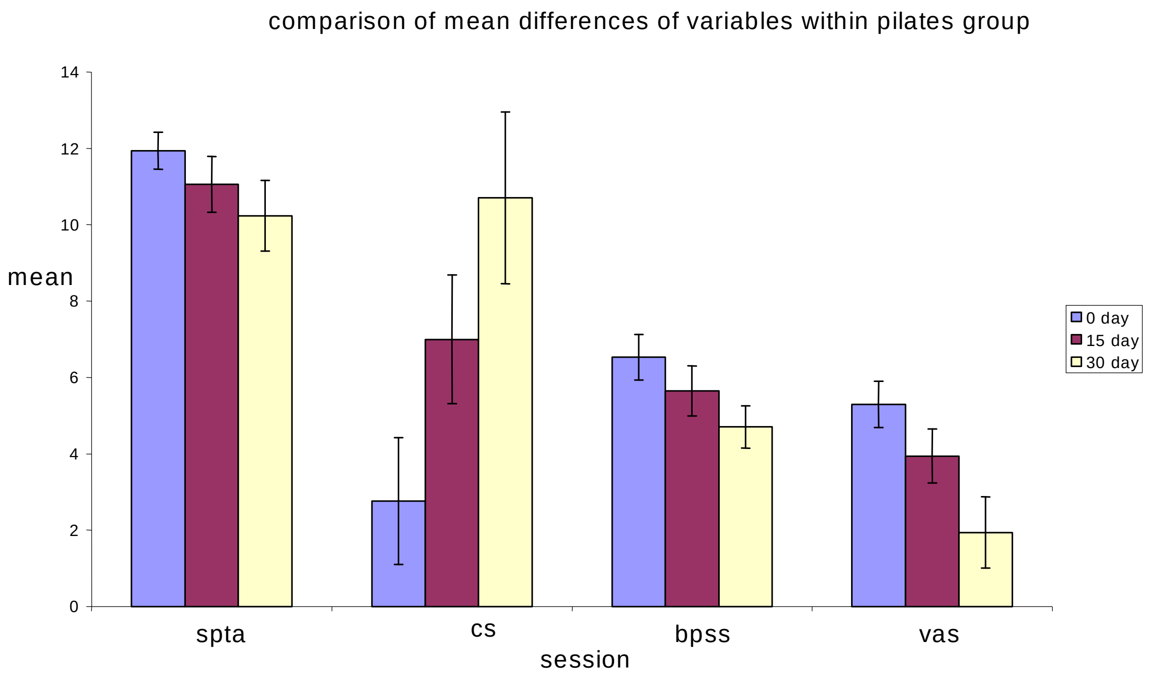
Graph 1- Mean (SD) of variables between Pilates and Mckenzie in 0-30 days



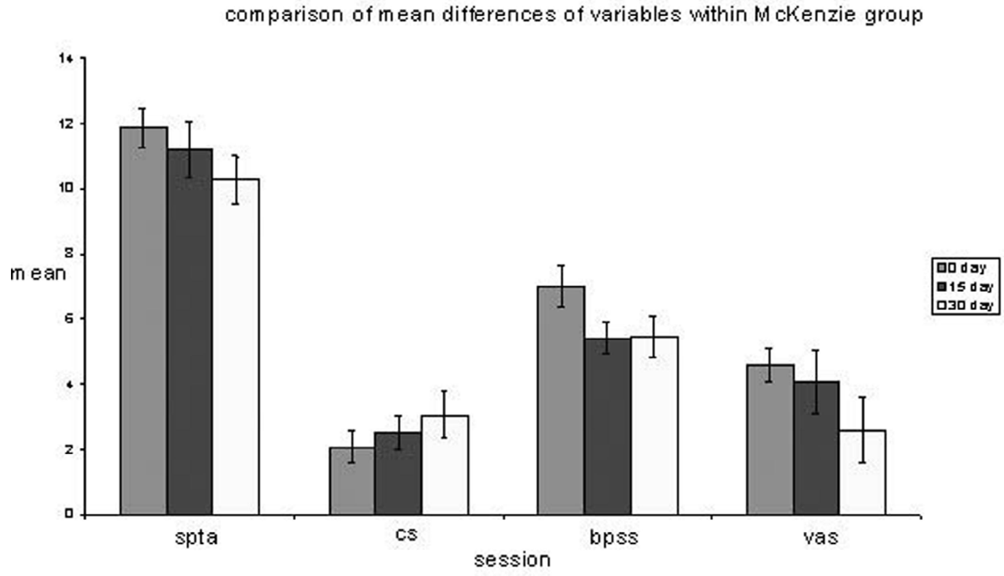
Graph 2- Mean (SD) of variables between Pilates and Mckenzie in 15-30 days



Graph 3- Mean (SD) of variables between Pilates and McKenzie in 0-15 days



Graph 4- Mean (SD) of variables within Pilates group



Graph 5- Mean (SD) of variables within McKenzie group

Discussion

This was a prospective study which compares the effect of Pilates and McKenzie exercises in rehabilitation of postural low back pain. After the analysis of the data, it was found that there was a significant improvement in the values of Core strength and VAS in the Pilates (group-A) as compared to the McKenzie (group-B).

Standing pelvic tilt angle

The result of analysis of SPTA did not show any significant improvement between the groups A and B. In Pilates (group A) the analysis showed no significant improvement in 0- 15 days session (0.805), but in 15- 30 days session significant improvement was seen (0.001), therefore significant improvement was seen in 0- 30 days session (0.000). In McKenzie (group B) the analysis showed no significant improvement in 0-15 day session (0.452), but in 15- 30 days session significant improvement was seen (0.001), therefore significant improvement was seen in 0-30 days session (0.001).

So, the result revealed that there were significant improvement in both the groups A and B but no significant improvement within the groups.

Joseph E. Muscolino stated that Pilates exercises have their effect on pelvic posture, on lengthening of spine and on the tone of abdomino-pelvic cavity[40].

Nelson et al stated that motion promotes healing in the musculo-skeletal system and that lack of motion leads to stiffness, cartilage degeneration, and muscle atrophy. The healing benefits of motion for LBP may be accomplished by stretching shortened tissues such as muscles, tendons, and ligaments, increasing blood flow to the lumbar extensors, mobilizing stiff joints and mechanically affecting disc pathology. Therefore, reduces hyperlordosis and thus reduces anterior pelvic tilt.[41, 42]

The other technique to reduce anterior pelvic tilt can be myofascial release. This includes involvement of neuromotor and central nervous system. When a muscle on one side of a joint contracts, the muscles on the opposite side should be inhibited for passive lengthening. This leads to change in the tone of the muscle by the process known as reciprocal inhibition. When myofascial release technique is applied over the shortened muscles, the antagonist muscles are released from a long, weakened and inefficient position. [45]

Core strength

The result of analysis of core strength showed significant improvement between the groups A and B (0.000). In Pilates (group A) the analysis showed no significant improvement in 0- 15 days session (0.775), but in 15- 30 days session significant improvement was seen (0.000), therefore improvement was seen in 0- 30 days session (0.000). In McKenzie (group B) the analysis showed no significant improvement in 0-15 day session (0.271), but in 15- 30 days session significant improvement was seen (0.019), therefore, significant improvement was seen in 0-30 days session (0.001).

So, the results revealed that there was slight improvement in both the groups but significant improvement was seen in group A as compared to group B.

This result of increase in core strength being more effective can be supported by the proposed mechanisms. The possible mechanism underlying in improvement of core strength and back pain is that Pilates encompasses core stabilization exercises that are not only static but also involves dynamic functional strengthening movements.[24, 25, 26]

In the early phase, there is recruitment of deep stabilizers (i.e. transversus abdominis, internal and external abdominal obliques, and multifidi muscles). The stabilizers consist largely of type I fibers and contracts at a submaximal level, which is less than 30% to 40% of a maximal voluntary contraction. This submaximal contraction happens simultaneously while disassociating the extremities or segments above or below the lesion. As the extremity disassociates from the trunk and the pelvis remains in neutral, the deep stabilizers work efficiently to maintain the control. This efficient use of the deep stabilizers controls pain and improves strength. [27, 28, 29.]

Cosio-Lima LM et al found that 5 weeks of Swiss ball core stability and balance exercises increased torso balance and EMG activity compared to conventional floor exercises in women [32]. Other studies have established that only some of the core muscles (i.e. the rectus abdominis) are activated to a greater extent during stability ball exercises. [33]

Several studies have shown that while stability ball exercises may improve core stability they are not necessarily any superior to conventional exercises.[34, 35, 36]

The strengthening of functional muscle groups (core muscles) leads to a more sophisticated neuromuscular system and improved lumbar spine support.[37]

The lumbar multifidus provides segmental stabilization to the spine, which is imperative in patients with lumbar spine instability. Researches shows that people with previous episodes of low back pain have delayed activation of the transversus abdominis and lumbar multifidus. So, by strengthening of the core muscles, the incidence of back pain can be reduced. [38]

Core muscle strengthening is the form of exercise that concentrates on the abdominal and lower back muscles. The advantage of this form of exercise is that it can reduce lower back pain and reduce back injury by allowing proper alignment of the spinal column.[38]

Back performance scale score

The result of analysis of BPSS showed no significant improvement between the groups A and B (0.943). In Pilates (group A), the analysis showed no significant improvement in 0- 15 days session (0.835), but in 15- 30 days session significant improvement was seen (0.000), therefore significant improvement was seen in 0- 30 days session (0.000). In McKenzie (group B) the analysis showed no significant improvement in 0-15 day session (0.424), but in 15- 30 days session slight significant improvement was seen (0.000), therefore significant improvement was seen in 0-30 days session (0.000).

So, the results revealed that there was significant improvement in both the groups but no significant improvement within the groups.

Cyrino et al. stated that suitable levels of muscular strength and flexibility are crucial for good musculo-skeletal performance, contributing for the preservation of healthy muscles and articulations during life, and that the decline of the flexibility levels gradually makes the performance of different daily tasks difficult, leading many times to early loss of autonomy. [43]

Jago R. et al stated that Pilates involves muscular exercises of low contraction impact, intensely strengthening the abdominal muscles and therefore improves flexibility. [44]

VAS

The result of analysis of VAS showed significant improvement between the groups A and B (0.000). In Pilates (group A) the analysis showed slight improvement in 0- 15 days session (0.011), in 15- 30 days session significant improvement was seen (0.000), therefore improvement was seen in 0- 30 days session (0.000). In McKenzie (group B) the analysis showed slight improvement in 0-15 day session (0.010), in 15- 30 days session significant improvement was seen (0.001), therefore significant improvement was seen in 0-30 days session (0.001).

So, the results revealed that there was significant improvement in both the groups but more improvement was seen in group A as compared to group B.

This result of improved VAS being more effective can be supported by various mechanisms.

Stability of the spine is provided by the integrated functioning of the active, passive and control subsystems (Panjabi, 1992). O'Sullivan et al. (1997) investigated the effect of 10 weeks of this training program on pain, disability scores and spinal range of motion. A group A completed a 10-week program beginning with contraction of the TrA and LM muscles, and progressing with increased contraction time and the application of a low load on the muscles by means of adding leverage through the limbs. A group B also underwent 10-weeks of physical activity which was directed by each patient's medical practitioner and consisted of general weekly exercises including swimming, walking and gym exercise. After training, the intervention group demonstrated a greater reduction in pain intensity, pain descriptor scores, Oswestry functional disability levels and improved hip flexion and extension ROM when compared to the control group. These differences were maintained at the 3, 6 and 30-month follow-up times. Decreased pain scores and increased ROM in patients with stability dysfunction are valid outcome measures of treatment efficacy and in the context of the study by O'Sullivan et al (1997), are interpreted as improvements in LPS (Liebenson, 1998). While these measures may assess overall treatment efficacy, they do not provide a direct measurement of the effect on LPS itself.

Limitation of study

- Larger sample size could have brought in more clarity in observed trends.
- A difficulty in the palpation of the bony landmarks could have caused some bias.
- Heterogenous group could have made the study more clear.
- A difficulty in exact contraction of transversus abdominis muscle.
- VAS being a subjective evaluation, is not a reliable method to quantify pain, McGill questionnaire could have been used.
- Test of homogenesity was applied in the initial values of all variables and the result was found that SPTA and BPSS were not significant & VAS and core strength were significant.

Implication of study

Low back pain is common affliction whose specific cause and precise treatment are still baffling to the medical professionals. Inability to pinpoint the proper structure at fault can result in array of problems. Thus, this study is an effort to ensure the proper rehabilitation of the postural low back pain.

Scope of future study

- The study can be carried out in larger population.
- The study can be carried out for male population also.
- As the assessment was carried out only for postural low back pain, the future study could be done for the rehabilitation of other types of back pain also.
- The study can be carried out with the help of pressure biofeedback unit.

Conclusion

32 subjects with reduced core strength, increased anterior pelvic tilt, increased VAS and increased back performance scale score were investigated to compare the effects of Pilates and

McKenzie exercises in rehabilitation of postural low back pain over a period of 30 days. The result showed significant improvement in core strength and VAS in both the groups as compared to SPTA and BPSS.

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Mirror Therapy in Stroke Rehabilitation

*** Deepti Goel, **Sharad Goel**
*M.P.T. (Neuro), Lecturer, Banarsidas Chandiwala Institute of Physiotherapy, New Delhi
**M.P.T. (Neuro), Senior Physiotherapist, Physiotherapy Deptt., Sarvodaya Hospital, Faridabad

Overview

Mirror Therapy is a form of Imagery in which a Mirror is used to convey visual stimuli to the brain through observation of one's unaffected body part as it carries out a set of movements.

It was first described by V.S Ramachandran.[7] The underlying Principle is that movement of the affected limb can be stimulated via visual cues originating from the opposite side of the body.Hence, it is thought this form of Therapy can prove useful in Stroke patients who have lost movements of an arm or leg.

Key Words

Stroke, Mirror Therapy,Visual Feedback

Introducation

Mirror Therapy helps in Stroke Rehabilitation.Stroke Rehabilitation has been revolutionized in the last decade through a combination of new techniques looking at brain recovery. Advances in basic sciences and clinical research are beginning to merge and show that the human brain is capable of significant recovery after Stroke, provided that the appropriate treatments and stimuliare applied in adequate amounts and at the right time.[6]

What is particularly exciting is the introduction of new therapies to further enhance thatrecovery.One of the newest therapy currently under study is Mirror Therapy in Stroke Rehabilitation.

Individuals with Hemiparesis typically demonstrates spasticity, muscle weakness and a persistent deficit in Movement co-ordination.Such in-cordination occurs at least in part because the neural circuitry responsible for mediating an action intention , and an executed action that precisely reflects that intention, is no longer intact either as a consequence of brain injury or secondary to immediate disuse. [1,5]

Visual Stimuli enhances Neuroplastic changes within the brain.Evidence of cortical reorganization of primary somatosensory cortex by visual feedback.(Mai Hofner et al 2003-04).. When normal somatosensory feedback is missing , visual feedback restores the information flow from the posterior parietal cortex to the Pre-motor cortex (Altschuler et al,1999). Recruting the Premotor Cortex or rebuilding the Motor Programme in the Premotor cortex by Providing Visual feedback could reduce pain and facilitate the limb movement(Rothgangel,2004)..To achieve visual feedback, patients can be treated with Mirror Therapy in which their limbs are separated by a Mirror.By looking in the Mirror at the unaffected side, patients can be 'fooled' in believing that the affected limb is moving effortlessely (Ramachandran and Hirstein,1998). [11]

Mental images of movement can be generated independent of overt behavioral output of a paretic limb. Humans are equipped with a simulation network that positions the motor system in anticipation of movement execution and provides the self with information about the possibility and meaning of upcoming actions.

Reprint requests: Deepti Goel
M.P.T. (Neuro), Lecturer
Banarsidas Chandiwala Institute of Physiotherapy,
Kalkaji, New Delhi 110 019
Mobile No.-9818494769

[2,4] The processes underlying motor imagery are similar to those active during actual movement. Actions generated using motor imagery adhere to the same rules and constraints that physical movements follow and the neural network involved in motor imagery and motor execution overlap, primarily in the premotor and parietal areas, Basal Ganglia and Cerebellum. [5]

How It's used

Using a Mirror Therapy is easy, by placing the affected limb(hand or foot) in the mirror box and unaffected limb in front of the mirror .Then using both limbs to do the gentle symmetrical exercises. It is very important to practice symmetrical movements only when the using the Mirror.Asymmetrical movements for e.g keeping the hand still and moving the hand outside the box or vice versa , may make the condition worse. Some patients may find using the Mirror difficult at first and more painful.If you find this then consider practising to visualize moving the limb first , think about easy movement initially such as clenching of toes or fingers and then move onto visualizing more complex and this may take several weeks. Improvement comes with repeated exercises.This Mirror box is made up of high quality polystyrene mirror which is foldable , making it truly portable , collapisible and light weight, this helps the patient to do exercises wherever and whenever patient wish.(V.S Ramachandran).

Literature Review

Various Research groups described the use of Mirror Therapy For Stroke Rehabilitation: Yavuzer G., Selles R., Sezer N., Sütbeyaz S., Bussmann J.B., Köseoglu F., Atay, M.B., Stam H.J.(2008):40 patients, mean age 63.2, within 12 months post stroke were recruited and randomized to one of two treatment groups. The mirror group (n=20) participated in non-paretic

side wrist and finger flexion and extension movements (while viewing a mirror image of the non-paretic limb in a mirror placed vertically between hands) in conjunction with standard rehabilitation. The control group (n=20) underwent standard rehabilitation in conjunction with a placebo version of the mirror treatment described above, where the mirror treatment was the same except that the unreflective side of the mirror was used. The treatments were carried out through a period of 4 weeks with a follow-up at 6 months (both real and placebo mirror treatments were 30 minutes per day, and standard therapy was 5 days per week, 2-5 hours per day). Assessments at baseline, 1 month (post-treatment) and 6 months (follow-up) were obtained on hand and upper extremity motor recovery as measured by the Brunnstrom stages, on hand related function as measured by the self-care items of the Functional Independence Measure, and on spasticity as measured by the Modified Ashworth Scale. Immediately following treatment, patients who received mirror therapy in addition to conventional therapy showed significant improvement in scores of the Brunnstrom stages for the hand and upper extremity as well as in the FIM self-care score (all p<.01). The above measures also showed statistical significance in favour of the mirror group for between-group differences measured from post treatment to 6 months follow-up (all p <.05). No significant between-group differences in improvement were found at either measured time for spasticity (p=0.925 - 4 weeks, p=0.875-6 months follow up)[12] Sütbeyaz S., Yavuzer G., Sezer N., Koseoglu B. F. (2007): 40 patients, mean age 63.5, within 12 months post stroke were recruited and randomized to one of two treatment groups. The mirror group (n=20) underwent non-paretic ankle dorsiflexion movement (while viewing a mirror image of the non-paretic limb in a mirror placed on the mid- sagittal plane and imagining it to be the paretic limb that was moving) in conjunction with standard rehabilitation. The control group (n=20) underwent standard rehabilitation in conjunction with a placebo version of the mirror treatment described above, where the mirror treatment was the same except that the unreflective side of the mirror was used. The treatments were carried out through a period of 4 weeks with a follow-up at 6 months (both real and placebo mirror treatments were 30 minutes per day, and standard therapy was 5 days per week, 2-5 hours per day). Assessments at baseline, 1 month (post-treatment) and 6 months (follow-up) were obtained on lower-extremity motor recovery as measured by the Brunnstrom stages, on motor function as measured by the functional Independence Measure, on spasticity as measured by the Modified Ashworth Scale, and on walking ability as measured by the Ambulation Categories. At 1 month, patients showed significant improvements in all categories and continued to improve to follow-up. Statistical analysis for between-group differences was only provided for improvement from baseline to follow-up (6 months). At follow-up the mirror therapy group showed significantly more improvement compared to the control group according to the Brunstrom lower limb stages (p=.002) and the Functional Independence Measure score (p=.001). No significant between-group differences in improvement were found for spasticity (measured by the Modified Ashworth Scale, p = .102) or walking abilities (measured by the Functional Ambulation Categories, p = .620).[9]Garry M.I., Loftus A., Summers J.J. (2004): 8 neurologically healthy individuals performed index-thumb opposition on one hand in each of the 4 following conditions: active (viewing the active hand), inactive (viewing the inactive hand), central (viewing a piece of tape midway between the hands) and mirror (viewing the mirror image of the active hand in a mirror placed in the mid-sagittal plane). A TMS pulse was aimed at the subjects' primary motor cortex in order to induce a muscle contraction of the contralateral hand (inactive hand), in the conditions measured above, and at rest. The occurrence and the intensity of the muscle contraction, and thus of M1 activity, were measured using EMG of the first dorsal interossei muscle. The mirror condition yielded the best results in terms of excitability, and reached statistical significance (p < .05) when compared to all studied conditions other than the active condition (p=0.069) which approached significance. This observation suggests that watching the mirror image of the active hand superimposed over one's inactive hand increases the likelihood of a contraction to being produced by TMS of the primary motor cortex (M1 area), implying that the activation threshold of the M1 motor neurons is decreased by mirror therapy in healthy subjects[3]Stevens J.A., Stoykov P.M.E. (2003):Two individuals with post-stroke upper limb hemiparesis, 14 months post-stroke (patient #1) and 6 years, 2 months post-stroke (patient #2) received a motor imagery training program: imagining movements of the wrist (extension, pronation, supination) and receiving mental stimulations of reaching as well as manipulating objects using a mirror box apparatus (the patient sits perpendicular to a mirror and watches their non-paretic arm move through space, while using the mirror to imagine that it is their paretic arm that is moving). This one hour training program was done 3 times per week for 4 consecutive weeks. The outcome measures include two standardized clinical assessments (Fugl Meyer Upper Extremity Motor Function Test, arm and hand dimension of the Physical Impairment Inventory of the Chedoke-McMaster Stroke Assessment), grip strength, wrist movement and 3 standardized measures of wrist functionality (Jebsen Test of Hand Function: light object, Jebson: heavy object, Jebson: card turning). Both patients showedan improvement (no p value indicated) in the performance of their paretic limb after the intervention, with patient #1 showing greater improvement. These improvements for both patients remained stable at 3 months follow-up.[10] Sathian K., Greenspan A.I. & Wolf S.L. (2000):A 57 year old male, 6 months post-stroke who reported difficulty moving his right side, and right-sided paraethesias, received a program consisting of weekly physical therapy visits at home (intensity of intervention is unknown). The initial intervention was to use a "motor copy" strategy that involved using a mirror to attempt bimanual upper extremity movements. As a progression to this intervention, the patient closed his eyes and focused on somatosensory cues from the intact limb and residual cues from the affected one. As the patient's motor functionbegan to improve, daily activities using the affected limb (forced use) were implemented.Outcome measures were grip strength, shoulder flexibility and time to complete common daily tasks (e.g.. pick up a pen, fold a towel into quarters etc). Following this progressive regimen, the patient improved in all these areas and was better able to use his affected hand in daily activities, such as dressing and inserting a key in a lock with greater precision and ease of movement. [8]

Discussion

The purpose of this article is to synthesize the relevant literature about Mirror Therapy in order to facilitate its integration into Physical Therapist Practice.

The literature suggests that the encouraging effects of Mirror Therapy improves the functional outcomes after Stroke by Facilitating Plastic re-organization of the cortex in the brain in response to Visual feedback.

Thus, Mirror may provide a valuable tool to access the Motor network and improve outcome after Stroke.

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Conference Calendar

2008 WINTER PHYSIOTHERAPY BREAKFAST: Organized by the APA Victorian Branch in conjunction with the Aquatic Physiotherapy Group Victorian Chapter: "Is It Worth Getting Wet?" presented by Jennifer Geytenbeek, M App Sc (Manip. Physio), B App Sc (Physio), Cert Hydro on 25 July 2008 at Kooyong Lawn Tennis Club.

For more information: http://apa.advsol.com.au/conferences/downloads/2008%20Winter%20Physiotherapy%20Breakfast%20-%20flyer.pdf.

ACT Referrers Forum: 7th August 2008 at 'University House' at Australian National University, Cnr Balmain Cres & Liversidge St, ACTON.

For More Information: http://apa.advsol.com.au/conferences/downloads/Referrers%20Forum%2008%20Flyer.pd.

Advanced Course In Functional Spasticity Management: Date: 9th August 2008 till 10th August 2008 at Garden City College, Bangalore.

7th Africa Region Congress: 18-08-2008 - 22-08-2008 at Abuja, Nigeria, Abuja, Nigeria.

XXIInd European Conference of Philosophy of Medicine and Health Care: 20-08-2008 - 23-08-2008 at Estonia.

Orthopaedic Physiotherapy: 22nd August 2008 at Bond University, Gold Coast.

For more information: http://apa.advsol.com.au/conferences/downloads/QOPN%20Draft%202008%20CONFERENCE%20PROGRAM.pdf.

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For More information: http://apa.advsol.com.au/conferences/downloads/Aquatic_Symposium.pdf.

Southampton Neurorehabilitation Conference: 04-09-2008 - 05-09-2008 at Southampton.

International Physical Therapy Day: 08-09-2008 - 08-09-2008.

International Conference on Ergonomics 2008: 20th September 2008 till 21st September 2008 at Garden City College, Bangalore.

2nd European Congress on Physiotherapy Education: 25-09-2008 - 26-09-2008 at Stockholm.

Cochrane Colloquium: 03-10-2008 - 07-10-2008 at Freiburg (Germany).

CSP Congress 2008: 17-10-2008 - 18-10-2008 at Manchester.

9th Turkish Sports Traumatology Arthroscopy and Knee Surgery Congress: 14-10-2008 - 18-10-2008 at Istanbul (Turkey).

3 CEOPS Schmerzkongress: 08-11-2008 - 08-11-2008 at Wien Austria.

5th Meeting of the European Federation of National Associations of Orthopaedic Sports Traumatology (EFOST): 26-11-2008 - 30-11-2008 at Antalya (Turkey).

4th Asia Western Pacific Region Conference: 22-01-2009 - 25-01-2009 at Mumbai India.

APA National Physiotherapy Student Symposium: 13th - 18th of January 2009 at Adelaide.

4th Bahrain Physical Therapy Association Conference: 22-04-2009 - 23-04-2009.

16th WCPT International Congress: 17-06-2011 - 22-06-2011 at Amsterdam.

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Contents