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Efficency of Motor Imagery with Conventional Therapy in Gait Training of Stroke Patient

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ABSTRACT

Total 30 participants including both male and female who were previously diagnosed by neurologist as having was recruited for the study. Subjects will be selected as per convenient sampling and assigned into two groups *i.e.* group-A (Experimental group) and Group–B (Control Group). In Group-A subjects were given motor imagery and conventional therapy both; in group-B subjects were given conventional therapy alone. Group A got 13 subjects with (mean age = 65.46±7.55) and Group-B got 13 subjects with (mean age = 65.69±5.58). Both programs were concluded in the respective participants home and hospital environment. None of the subjects attended physiotherapy for lower limb anywere else during the study. Baseline measurements was taken at the start of treatment program, using gait variables as outcome measures *i.e.* stride length, step length, Gait velocity & Cadence. Results of post reading in both groups (for stride length (p=0,928) and post stride (p=0.592), for pre step length (p=0.777) and post step length 9p=0.631), for pre gait velocity (p=0.4590 and post gait velocity (p=0.959), for pre cadence (p=0.986) and post cadence (p=0.844) show significance improvement, but improvement in Group-A was more than in Group-B. As per the results of the present study, Motor imagery program is found to be effective when given with conventional therapy in improving gait in stroke subjects. Moveover it can be done easily by the patient as it takes effort and motivates the subject for performing the desired task. It also does not fatigue the patient. Thus, it is a feasible method and can be applied in conjunction with conventional therapy while treating stroke patients with gait issue.

Keywords: Motor imagery; Gait velocity; Cadence; Stroke.

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INTRODUCTION

Stroke is an acute onset of neurological dysfunction due to abnormality in cerebral circulation with resultant sign and symptoms that correspond the focal area of brain. This can be due to ischemic caused by thrombosis caused by thrombosis or embolism or due to a hemorrhage.[1] Stroke can result in many different disabilities, ranging from motor control and urinary incontinence to depression and memory loss. Stroke usually occurs on only one side of the brain, so decreased motor control (the ability to move muscles in a co-ordinated manner) usually develops on only in eside of the body. In fact, one side of the body may be paralyzed (hemiplegia), or muscles on the affected side may be weakened (hemiperesis). Because of the weakness of paralysis in large muscle groups, injuries from fall are common complications of motor control disturbances.[2] There is alternation in tone after stroke. Flaccidity (hypotonicity) is present just after stroke and is due primarily to the cerebral shock. It is generally short lived, lasting a few days and weeks. Spasticity (hyper tonicity) emerges in about 90% of the cases and occurs on the side of the body opposite the lesion. Spasticity in upper motor syndrome occurs predominately in the antigravity muscles. In the lower extremity spasticity is often strong in the pelvic retractors, hip adductors and internal rotators, hip and knee extensors, plante rflexors and supinators and toe flexors. Spasticity results in tight (stiff) muscles that restrict volitional movement. Posturing of the limb (eg, a tight fisted hand with the elbow bent and held tightly against the chest or a stiff extended knee with a plantar flexed foot) is common with moderate to severe spasticity. Reflexes are altered and also vary according to stage of recovery. There is initially hypo reflexia with flaccidity, then hyper reflexia with spasticity.[3] Gait is altered following stroke pwing to a number of factors. Common problem associated with hemiplegia gait according to phase are: in stance phase; weak hip extensors, flexors contracture at trunk/pelvis, trndelenburg limp (weak abductors), scissoring (spastic adductors) at hip, flexion contractures, werak hip and knee extensors poor proprioception, ankle dorsiflexion range past neutral at knee, equinus gait (spasticity or contracture of gastrocnemius soleus), varus foot 9 hyper active or spastic tibialis anterior, post tibialis, toe flexors and soleus), unequal strep length at ankle/foot. In swing phase; week abdominal muscles weakness of flexors muscles at trunk/ pelvis, weak hip flexors, poor proprioception, spastic quadriceps, abdominal weakness (hip hikers) at hip, in adequate knee flexors (spastic quadriceps), weak knee extensors (spastic hamstrings) at knee, plantar flexors contracture or spasticity, weak dorsiflexors, delayed contraction of dorsiflexion, toe frag during midswing at ankle/foot.[3] Walking after stroke is often impaired and restricted to short distances. The average walking speed of people with hemiparesis is lower then that of people without known pathology or impairement, with values ranging from 0.23 to 0.73 m/s, depending on severity of the hemiparesis. Characteristically for these individuals, stride length and cadence are lower than normal and a greater proportion of the gait cycle is occupied by double support and same phase duration of both lower extremities (particularly of the unaffected lower extremity), as compared with people without hemiparesis.[4] Mental imagery is using our "minds eye" to picture situation without actually being there. When we look forward to a particular events we use imagery. Sometimes we visualize the expected outcome of an upcoming event, and this affects our motivation. Picturing pleasant consequences can lead to excitement, even an emotional high, but imagining negative outcome can evoke fear. An individual can imagine themselves performing desired behaviors, the greater the beneficial impact of this technique on actual performance. Motor imaginary is a dynamic state during which an action is mentally stimulated without any body movement.[10] It is the active process of reliving sensation with or without exyernal stimului.[13] This is facilitated by the use of images brought about by combination of different modalities, *i.e* visual, auditory, tactile, kinesthetic, gustatory. When movement of an action of aperson or objects is imaged, this is called movement imagery. Specifically when it is human body that is imaged by the internal reactivation of action within working memory without overt motor out put it is called motor imagery.[5] This shows that the rehearsal of a physical activity in absence of an gross muscular movement through motor imagery improve motor performance.[5] Thus patients can continue motor imagery training even when they are already physically exhausted or when supervised therapy sessions have finished.[5] Motor imagery has its origin in the sports psychology and behavior psycology.[6] The "Psycho neuromuscular theory" by Jacobson in early 1930s shows that there is myoelectrical changes related to imagined movement.[6] A large number of functional neuro-imaging studies have demonstrated that motor imagery is associated with the specific activation of the neuronal circuit (The supplementary motor area, the primary motor cortex, the inferior parietal cortex, the basal ganglia, and the cerebellum) involved in the early stage of motor control (*i.e* motor programming). Such physiological data gives support about common neural mechanisms of imagery and motor preparation. Motor imagery activates motor pathway. Functional brain imaging studies have indicated that several cortical and subcortical areas activation during actual motor performance are also active during imagination or mental rehearsal of movement.[9] In the absence of the movement, there is detectable EMG activity during motor imagery, this shows there is an cortical excitability with no changes in spinal excitability.[7] Motor imagery is a high level process which however manifests itself in the activation of those same cortical circuit that are normal involved in the movement execution.[8] Reports have described the contribution of motor imagery practice for improving upper extremity functions in patients with hemiperesis following stroke.[9] Previous case reports also suggests motor imagery is useful for the enhancement of walking ability in patients following stroke. And also imagery training can be considered as a useful option for restoration of ambulation for individuals with chronic hemiparetic stroke who are unable to participate in physical gait training.[11] Imagery practice should focus on its specific impairement during gait in order to affect the performance of the paretic lower extremity with conventional therapy.[4-10]

METHODOLOGY

Sample: Total 30 participants including both male and female who were previously diagnosed by neurologist as having was recruited for the study.

Subjects were taken from different hospitals of Delhi, Haryana and Dehradun.

Study Design: Experimental study.

Method of Selecting and Assigning Subjects

Subjects will be selected as per convenient sampling and assigned into two groups i.e. Group-A (Experimental group) and Group–B (Control Group). In group-A subjects were given motor imagery and conventional therapy both; in Group-B subjects were given conventional therapy alone.

Inclusion Criteria

- Ambulatory stroke patient can ambulate 16 m (with or without assistive device).
- Stroke of at least 3 month duration.
- No serious unstable medical condition.
- Not receiving any other form of physiotherapy for lower limb.
- Mini mental state examination (>23).
- Movement Imagery Questionnaire – Revised second (MIQ-RS0): (score of 98 is good, score of 14 is worse).

Exclusive Criteria

- Spinal deformity
- History of spinal trauma or head injury
- Any other neurological disease
- Unhealed fractures
- Peripheral arterial occlusive disease
- Orthopaedic disorders involving any joint of lower limbs
- History of neurological disease other than the chronic stroke

Instrumentation

- Plinth or couch (Performing motor imagery)
- Stopwatch (For evaluation of gait velocity)
- Plain surface for walk test (at least 16 m)
- Chart paper (6+6 m per subject)
- White board marker (for heel strike mark)
- Adhesive tape & double tape (For attachment of marker with shoe)
- Inch/Measurinng tape (measurement of space and chart)
- Scale (measurement of step length and stride length)

Outcome Measure

- ***Stride length Measurement:*** (the average of middle stride) cm
- Step length measurement (the average of the middle three steps) cm
- ***Gait Velocity Measurement:*** (6m x 60 sec ÷ time for walk in sec) m/min.
- ***Cadence Measurement:*** (# marks x 60 ÷ time for walk in sec) step/min.

Fig. 1: Stop watch

Fig. 2: Measuring tape, measuring scale, white board marker and adhesive tape

PROTOCOL

This study consisted of two groups: Experimental group (A) and Control group (B) subjects were chosen as per the inclusion and exclusion criteria, and informed consent was obtained from all subjects after the procedure was explained to them.

The 4 weeks intervention was given to the subjects of both groups alternately, 3 days a week for Group A and 3 days a week for Group B. 45-50 minutes protocol for Group A and 30-40 minutes protocol for Group B.

Group A *Protocol*[1,4,12]

This group received Motor imagery (10-15 minutes) & Conventional therapy (30-40 minutes) both and it was given in single session of 40-50 minutes. The program was conducted for 3 times per week. Total duration of both programs was for 4 weeks.

Motor Imagery Techniques used

The internal as well as external imagery scenes were applied in this intervention protocol.

The 2 main goals were

1. To facilitate movement and posture of the affected lower extremity during gait by focusing on specific impairements.
2. To enhance functional walking within subjects own environment.

Conventional therapy Technique used

The conventional therapy for gait training in the group was given as per the protocol of Group B.

Group-B Protocol

In this group Intervention of conventional therapy alone was given for 30-40 minute. In conventional gait training, patients practiced functional (1) Task specific locomotor skill walking forward and side stepping (5 minutes)[1,16] (2) Elevation activities (e.g. step-up/step-down, lateral step-up, stair climbing) (3) Community activities (walking on ramps, curves and over and around obstracles), and (4) Quadriceps strengthening.[15]

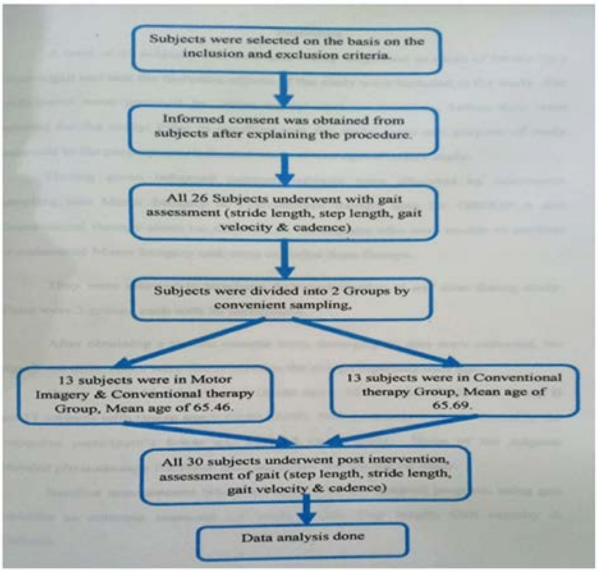

Fig. 3: Flow chart according to Protocol.

Procedure

A total of 26 subjects who were previously diagnosed as cases of strokes by a neurologist and met the inclusive criteria of the study were included in the study. The participants were screened by mini mental state examination, before they were selected for the study, Prior to enrolling into the study, need and purpose of study were told the participants. Informed consent was signed before study.

Having given informed consent, subjects were allocated by convenient sampling into Motor Imagery & Conventional therapy both *i.e.* Group-A and Conventional therapy alone *i.e.* Group-B Participants who were unable to perform or understand Motor Imagery task were excluded from Groups.

They were allowed to terminate their participants at any time during study. They were 2 groups with 26 participants.

After obtaining a written consent from, demographic data were collected. No significance differences were found between the groups regarding their age.

Group-A got 13 subjects with (mean age = 65.46 ± 7.55) and Group-B got 13 subjects with (mean age =65.69 ± 5.58). Both programs were concluded in the respective participants home and hospital environment. None of the subjects attended physiotherapy for lower lmbanywerealse during the study.

Baseline measurements was taken at the start of treatment program, using gait variables as outcome measures i.e. stride length, step length, Gait velocity & Cadence.

GAIT ASSESSMENT

The procedure requires only a stop watch, two felt tip marking pens with was hable ink, and a 16 m (53 feet) walkway, That is premeasured and marked with masking tape at four points. A halfway, an outside cement area at a clinic, or patients home as well as a portion of a clinic floor can be used for the walkway. The walkway is marked to show a center area 6m long and two 5 m areas on each end. Measurement are made within the 6 m area only; the two 5 m areas allow for warming up to "normal" velocity before measurement and slowing down after measurement. Using these extension of the measurement area of the walkway is intended to eliminate measurement errors.

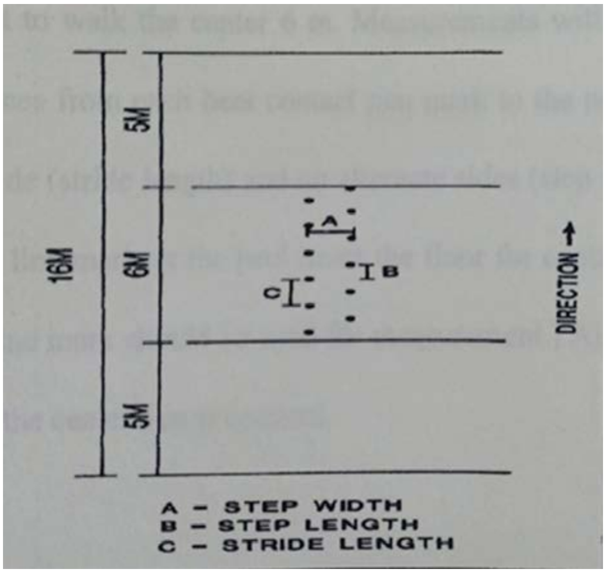

Fig. 4: Shows pattern of steps.

Felt tip marking pens are taped to the back of patients shoes so that the tip just reaches the floor when he is standing. Before the procedure, the patient should take a few steps at the side of walkway to ensure that the markers are correctly positioned to indicate heel contact.

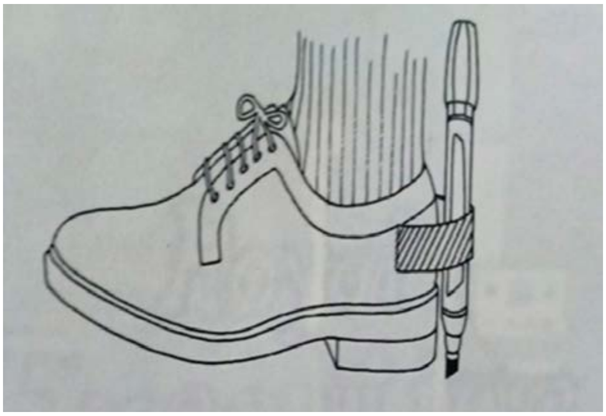

Fig. 5: Shows attachment of marker to the shoe with adhesive tape.

The patient is instructed to walk at his usual walking speed from one end of the 16 m walkway to the other end. The therapist, using a stopwatch, record the time taken for the patient to walk the center 6 m. Measurements within the 6 m area are then made of distance from each heel contact pen mark to the next heel contact pen mark on the same side (stride length) and on alternate sides (step length). (Sometimes the marker leaves a line mark as the heel nears the floor for contact. The point at the termination of the line mark should be used for measurement). Also, the total number of contacts marks in the center 6 m is counted.

Motor Imagery Technique:

For training gait by motor imagery therapist/ myself was in front of subjects who was sitting on the chair with arm rest or lying on the bed as per the comfort of subjects. Initially subjects were introduced with Motor Imagery technique. They were well explaned about it.

Then imagery gait was practiced in the living room, emphasizing imagery experience, using all sensory modalities. For example give instruction to subjects to imagine the scene of the pictures on the wall as if you are watching it in reality. Timing, sequencing, and spacing of the Mental Imagery practice activities were based on established principals taken from the motor learning discipline and on report of the application of these principles to stroke rehabilitation. If subjects was not able to do or was doing in wrong way, therapist/myself guided how to imagine things/activity with relaxed and calm manner. Then the, subjects were told for another task for example try to use your imagery ability to hear the sound of your footsteps on the floor. Individuals engaged in such imagery tasks are consciously aware of it and able to report the content of the imagined acts or scenes.

Specific impairments chosen as targets for intervention were (1) Fore foot initial contact (2) Deficient push-off during stance, (3) Reduced knee flexion during swing. Concomitantly, imagery practice was directed towards improving (1) Gait speed and symmetry, (2) Towards negotiating walking routes indoors and outdoors (e.g. public buldings, uneven terrains). Additionally, the gait was practiced under variable circumstances with only intermittent or minimum oral feedback presented during practice.

Each Practice Session was Composed of: (1) the provision of explicit information on task characteristics and environmental circumstances (1-2 minutes), (2) imaging of walking activity from an external perpective (3-8 minutes), (3) imaging of walking activity from an internal perspective (3-8 minutes),[14] and (4) refocusing of attention on the immediate surroundings and on genuine body position (1 minute).

Time Schedule and Major tasks that were Practiced are:

First week: Familiarization with motor imagery practice. Practice imagery gait in the living room, emphasizing imagery experience, using all sensory modalities.

Example: "Try to imagine the scene of the pictures on the wall as if you are watching it in reality. "Try to use your imagery ability to hear the sound of your foot steps on the floor."

Second Week; Practice of missing components (impairement) in gait performance of the paralytic lower extremity, focusing on the knee flexion during swing, on heel contact during stances, and on the timed application of propulsive force during push-off.

Examples; "Try to see your left knee flex as high as your knee." "Try to feel your left knee flex as high as your right knee." "During each step, price to lifting your leg, try to feel that your foot is strongly pushing backward towards your floor."

Third Week: Practice continued as in second week, with additional emphasis on loading of the affected side during stance and on increasing gait speed.

Example: 'In each step, feel that you some what extended the time you stand on your unaffected leg future ahead." "Imagine that you are walking faster than your current tempo." "Feel that you move each of your feet father ahead.

Fourth Week: Further gait practice focused on integrating the prior practice component into the strep cycle and on increasing symmetry and gait velocity.

Examples: "Try to 'see' both of your legs making the same movement." "Feel each foot going up the same height as the other." "In each step, feel forefoot is strongly pushing against the floor prior to 'take off.'

Reinforcement was applied through imagery of feeling of confidence in gait performance and of successful accomplishment of the practiced tasks. That is, the trainer encouragement feeling of safety, calmness and satisfaction as well as after completion of the imagery gait.

Conventional Therapy for Gait

Task-Specific Locomotor skill walking:

Subjects standing with hip in correct alignment, subjects practices stepping forward then backward with intact leg, making sure he/she extends his/ her affected hip as he/she steps forward. I stand on either in front or on affected side and encourage the subjects to take weight through affected leg. Like wise instruct to subjects for forward walking. Subjects was instructed for side walking by hip abduction and takes long step at one side and follow by the other step.

Elevation Activities:

Subjects was instructed to take a step-up on stairs by flexing hip and knee, with giving load on the forward limb and elevate his/her body to climb the one stair up. Then subjects was instructed for step-down the stair by hip extension of one limb and hip flexion and knee flexion of others. Assistance was required where subjects is not able to perform the activity due to fear of falling. Likewise subjects was instructed stair climbing.

Community Activities:

Subjects perform walking on ramps, curves and uneven terrains as this increase the gait speed by increasing endurance. The over and around obstacles task was also given to the subjects by placing a stick in front of subjects and instructed for walk over the stick.

Quadriceps Strengthening:

Resistive strength training was given to subjects by trying weight cuff to the foot, and performance extension of knee.

RESULT

26 Subjects with stroke who met the inclusion criteria participated and completed the study. No significance differences were found in the base line values of age and height among groups.

The mean and standard deviation of age, height and weight was calculated for the 30 subjects as follows age - 65.45 ±7.55, height - 169.233 ± 6.55.

Students T-test was done to compare the data of pre stride length between the groups (p=0.928).

Paired t-test was done to compare the data of the stride length with in the groups for stried length both the groups showed significant difference [Group-A (P=0.0023) and Group-B (P=0.000)].

Students T-test was done to compare the data of post stride length between the groups (p=0.592).

Students T-test was done to compare the data of pre step length between the groups (p=0.777).

Paired t-test was done to compare the data of step length within the groups. For step length both the groups showed significant difference [Group A (p=0.024) and Group B (p=0.002)].

Students T-test was done to compare the data of post length between the groups (p=0.0631).

Students T-test was done to compare the data of pre Gait velocity between the groups (p=0.459).

Paired t-test was done to compare the data of velocity within the groups. For Gait velocity both the groups showed significance difference [Group A (p=0.015) and Group B (p=0.000)].

Students T-test was done to compare the data of post Gait velocity between the groups (p= 0.959).

Students T-test was done to compare the data of pre cadence between the groups (p=0.986).

Paired T-test was done to compare the data of Cadence within the groups. For Cadence both the groups showed significance difference [Group-A (P=0.024) and Group-B(p= 0.002)].

Students T-test was done to compare the data of the post cadence between the groups (p= 0.844).

- From the above results we can say that both treatment were effective for both groups.
- From the above results, we can say that Group A showed significant improvement as compared to Group B in step length, stride length, Gait velocity and cadence.
- Gait assessment of Group A showed significant improvement at post intervention compared to Group B.
- From these results we can conclude that the Groups A is better that Group B.

Table 1: Shows Mean d and SD of Pre-Step length & Post-Step length (STL) for Group-A and Group-B

Group-A				Group-B			
STL				STL			
Pre		Post		Pre		Post	
Mean	SD	Mean	SD	Mean	SD	Mean	SD
31.42 t=2.59 P=0.024	7.7	38.17	12.09	31.13 t=3.825 P=0.002	7.17	36.07	9.2

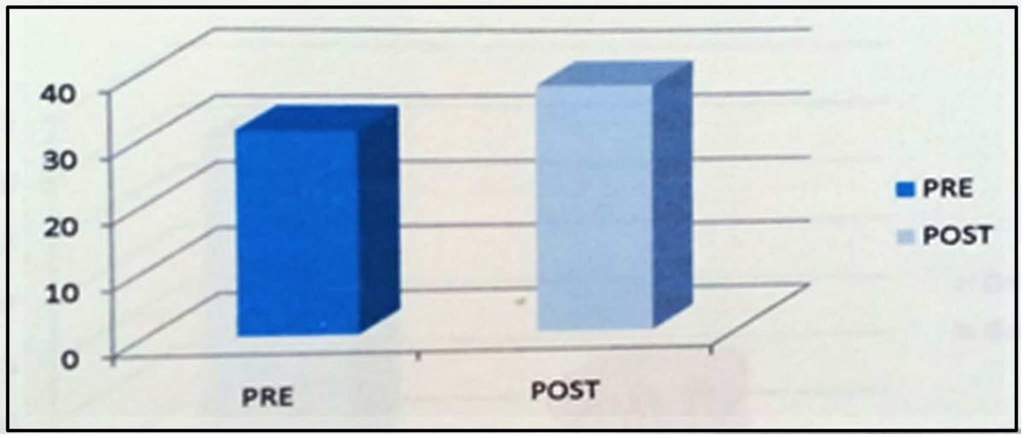

Fig. 6: Shows improvement in Post-Step length than Pre-Step length in Group-A

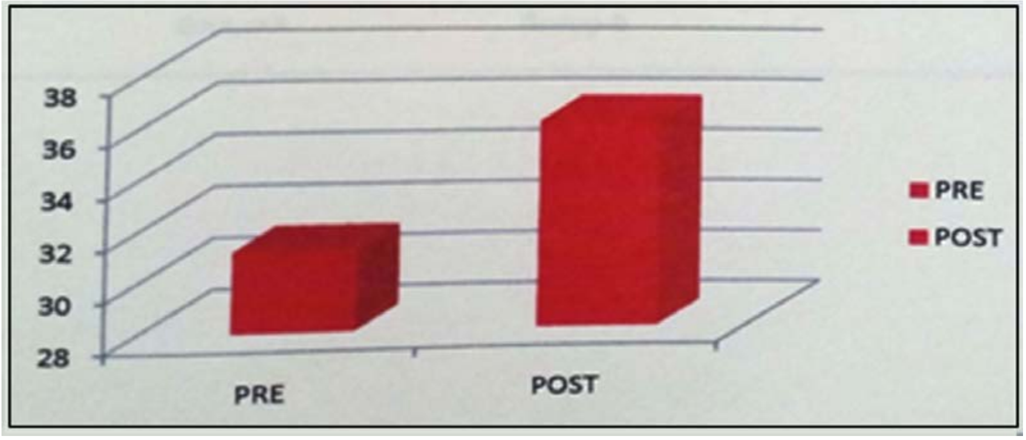

Fig. 7: Shows improvement in Post-Step length than Pre-Step length in Group-B

DISCUSSION

Our study aimed to improve walking. Walking is basic mobility and enhances independence to any one. The ability to walk independently is a life enriching activity and the most efficiently way of getting from one place to another in the course of our daily lives.

The temporospatial gait characteristics indicate that cadence is especially adversely affected by stroke and that the improvement in gait speed is mainly due to an increase in stride length and, to a lesser extent, to an increase cadence. There significance improvement in post interventional reading of (for stride length p=0.023, for step length p=0.024, for gait velocity p=0.015 and for cadence p=0.024) Group-A, because as per previous studies conventional therap with motor imagery with conventional therapy is effective in the time difference to perform the task from pre tp post–intervention.[24] S.A. Zimmermann *et.al* says that evidence suggests Motor imagery provides additional benefits to conventional physiotherapy or occupational therapy.[10] Some author says that locomotor imagery training can be considered as a useful option for restortation of ambulation for individuals with chronic hemiperesis stroke who are unable to participate in physical gait training.[11] Ehrsson *et.al* showed an activation of specific limb area in the primary motor cortex.[13] Motor Imagery is a dynamic state during which the representation of a specific motor action is internally activated without any motor output. In other words motor imagery requires the conscious activation of brain region that are also involved in movement prepration and execution, accompanied by a voluntary inhibition of the actual movement. Some autor reported that the activation of the pre-supplementary motor area and the primary motor cortex during imagery of locomotion movements. Researchers hypothesized that movement execution; motor imagery and action observation S are all driven by the same basic mechanism. Motor imagery and action observation are conceived as ″offline‶ operation of the motor areas in the brain. Researchers also reported that better equilibrium characteristics in elderly women as measured by walking balance and foot placement measures as a result of a combined treatment of motor imagery and physical therapy.[17] As Motor Imagery intervention did not sufficiently modify the asummetry that is an inherent featuers of hemiperisis so it should be given with conventional therapy.[4] Some researchers says that Imagery, in association with therapy, appears to be a non invasive, efficacious complement to traditional therapy that substantially reduces impairement and improves outcomes.[13] On other side there is significant improvement in post–reading of (for stride length p=0.000, for step length p=0.002, for gait velocity p=0.000 and for cadence p=0.002) Group-B also because as per the previous research results, conventional therapy for stroke is effective for getting ambulation and improvement in gait. Researchers say that Task specific activites with strength training are effective therapeutic intervention for post stroke. Possible mechanisms accociated with response to therapy were related to improve motor unit activation associated with increased strength in key muscles used in gait.[18] Author present an intriguing hypothesis that overgroung gait training such as walking while forward, sideways, may be better suited in educating patients regarding safety, while encouraging participation in therapeutic exercises to improve strength cardiovascular fitness, movement efficiency and agility,″ Overground gait training improves locomotor function and is a major goal of rehabilitation, and if patient want to improve walking they need to practice walking. Overground gait training represents the most task specific approach in improving gait for individuals with hemopresis after stroke.[19] It was also hypothesized that strengthening and physical conditioning are to reduce impairement and disability in chronic stroke surviors.[20] Stroke rehabilitation provides a targeted and organized plan to relearn functional lost in the shortest period of time possible. Some studies suggests that successful and meaningful recovery is most likely to be accomplished if you are dedicated and keep a high level of motivation during your rehabilitation process.[21] It is recognized that participation by patients in active physical therapeutic programs probably provides direct influence on the process of functional reorganization in the brain and enhances neurological recovery. A key aspect of neutral plasticity that has important implication for rehabilitation is the fact that the modification in neuronal networks are use dependent. Clinical trail have shown that forced use and functional training contributes to improve function.[22] Standardized community based rehabilitation therapy also help stroke patients to improve their neurological function.[23] Clinical studies demonstrated that training or inpatient rehabilitation increases cortical representation with subsequent functional recovery, whereas a lack of rehabilitation or training decreases cortical representation and delayed recovery.[23] Results of post reading in both groups (for stride length (p=0,928) and post stride (p=0.592), for pre step length (p=0.777) and post step length 9p=0.631), for pre gait velocity (p=0.4590 and post gait velocity (p=0.959), for pre cadence (p=0.986) and post cadence (p=0.844) show significance improvement, but improvement in Group-A was more than in Group-B. In past two studies it was seen that Motor imagery provided additional benefits to conventional physiotherapy when given for upper limb functioning.[10] This can for the post Intervention results of the present study where the mean value of experimental group showed better results than the mean value of control group. Researchers determined that embedded MI (Motor Imagery with conventional therapy) is superior to added MI (conventional therapy separately). Brain areas activated during MI and real movement show a strong congruity for single arm movement as well as complex whole body movement in stroke patients.[6]

These studies and researchers give evidence that the Motor Imagery with conventional therapy is beneficial in gait rehabilitation. Motor Imagery take less effort and gives motivation to subjects for performing hence easy to apply.

Limitation of the Study:

- Small number of subjects were recruited for the study.
- Stroke subjects were less than or equal to 3 years only.

Future Research:

- The study can be repeated using a large sample size.
- The study can be repeated using subjects with duration of stroke more than 3 years.
- The follow up of the present study can be done.
- Sam study can be done on different

population where gait is affected, e.g. Parkinsonism.

CONCLUSION

As per the results of the present study, Motor imagery program is found to be effective when given with conventional therapy in improving gait in stroke subjects. Moveover it can be done easily by the patient as it takes effort and motivates the subject for performing the desired task. It also does not fatigue the patient. Thus, it is a feasible method and can be applied in conjunction with conventional therapy while treating stroke patients with gait issue.

Clinical Relevance

Motor imagery program can be given together with conventional therapy to improve gait in stroke subjects and it can be done easily as it takes less effort and gives motivation to the subjects for performing tasks. Thus it does not fatigue the patients.

Ethical Clarence: It is a bonafied work done by me and I have not taken any part of thesis from anywere.

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Relationship between Trunk Leg Ratio and Peak Flow Rate in Young Girls

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ABSTRACT

Background & Objectives: Peak expiratory flow rate (PEFR) is an effort dependent. It remains at its peak for 10 sec. Peak expiratory flow rate may be affected by some factors affecting the normal function of the respiratory system. Such factors include the body constitution such as height, weight, sex, age etc. A study of peak expiratory flow rate and its relationship with trunk leg ratio. The trunk-leg ratio (TLR) was used in apparently healthy young females of age 10-15 years. A better understanding of the association between Trunk-leg ratio and PEFR may identify those with high chances of respiratory diseases.

Methods: A cross sectional study was conducted in which the peak flow rate of 80 school going girls, aged 10-15 years was measured with a peak flow meter. A peak flow meter and a measuring tape to scale height were used to measure the participants and written consent from their guardian was obtained before the start of procedure.

Results: There was no significant correlation between PEFR and trunk to leg ratio and trunk length and PEFR. A low correlation was found between leg length and trunk to leg ratio.

Interpretation & Conclusion: The study suggest that the trunk to leg ratio has no significance with young girls in this study.

Keywords: Peak expiratory flow; Young children; Height; Trunk to leg ratio.

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INTRODUCTION

Peak expiratory flow rate (PEFR) is the maximum flow rate that occurs when you exhale forcefully through the lungs. PEFR usually indicates a large airway flow and is dependent on the patient's effort and muscle strength. Peak expiratory flow is a simple and reliable test for diagnosing and monitoring the development of airflow limitation and evaluating response to treatment. Peak Expiratory Flow Rate (PEF), also known as Peak Expiratory Flow Rate (PEFR), is the maximum value at which a person can breathe out as measured by the Peak Flow Meter, a small device used to monitor the person breathing. It measures airflow through the bronchi and how clogged or obstructed are airways. Peak expiratory flow measurement (peak flow) is a simple measure of the maximum flow during exhalation after a full inspiration. Patients can learn the procedure quickly, and the necessary equipment is inexpensive and widely available. Large organizations and advocacy groups have launched patient oriented websites with clear videos showing necessary procedures that can help doctors choose to initiate home testing for patients. Age, gender, height, weight, age difference and race are factors affecting PEFR. The PEFR among infants, children, and adults shows variation between different ethnic groups. PEFR readings are higher when the patient is healthy and lower when the airway is restricted.

Considered a good indicator of bronchial hypersensitivity and does not require saturation correction for temperature. PEFR maintenance can be performed correctly for most patients over 5 years of age. The PEFR measurement is mainly used for home monitoring of asthma, making it useful for short-term and long-term monitoring of patients. When properly performed and well defined, maximal assessment can provide patients and physicians with objective information about treatment decisions regarding the risk of death and has economic significance for individuals and health care systems.

Well known body measurements such as body mass index (BMI) and waist circumference (WC) are not reliable indicators of adipose tissue, but are universally accepted to be associated with heart disease. Therefore participants included in this were of normal BMI. There is association between height and PEFR, though there is no significance between trunk to leg length ratio. In this trunk to leg length was obtained to relate with peak expiratory flow rate. Trunk to leg length ratio can be a important for identifying elevated risk of respiratory diseases. From a public health perspective, a better understanding of the trunk to-leg ratio and other parameters may provide an opportunity to identify individuals at high risk of cardiopulmonary disease. The Trunk-to-Leg Ratio (TLR) or Leg-to-Body Ratio (LTR) is the ratio of leg length and trunk length, and a higher value of TLR indicates a higher leg length for a given height. Leg length is calculated as the difference between height and sitting height, TLR is the value obtained by dividing the leg length by the sitting height.[3]

Leg length is an indicator of the impact of obesity on the development of children of the prepubertal environment, because the increase in height to adulthood is primarily due to leg growth. Respiratory diseases are major diseases that affect children, especially in India are the leading cause of childhood morbidity and mortality.

There has been an increase of in children with respiratory diseases, especially due to factors such as environmental pollution. Therefore, pulmonary function tests are very important in the evaluation of children. PEFR is one of the lung tests that is useful in the evaluation of lung diseases, especially asthma. It also helps monitor disease progression and response to treatment.

Peak expiratory flow rate (PEFR) is a measure of the effort resulting from a large airways approximately 100-120 ms after the start of a forced exhalation. It is at the maximum for 10 ms.

The main influence on the PEFR is the diameter of the airways, which is regulated by bronchial tone. Other factors that affect PEFR are the strength of the muscles and the elastic tissue of the lungs. There is a positive correlation between height, weight, chest circumference and PEFR. PEFR is important for diagnosing and diagnosing lung function by predicting changes in air quality. Many studies have been done to determine the relationship between TLRs and cardiovascular risk, but few studies have been done on this topic. This study aimed to evaluate the relationship between body leg ratio and peak flow in healthy adolescent girls aged 10-15 years.

Finally, all children were voluntarily selected for this study. A total of 80 participants were included in this study. All participants were healthy preteen girls aged 10 to 15 years. All participants had a normal BMI.

BMI measure your height and weight, measure your height with a tape measure and take your weight with a scale. Use a tape measure to measure body length and leg length. All measurements are in centimeters. Body length is measured from the tip of the shoulders to the ilium.leg length is the distance from the iliac wing to the floor. All participants were asked to remove their shoes before measuring their leg length.

A peak flow meter was used as the measurement. An instrument was used throughout the course. There are markings and mouth piece in the graduated region of the device. Marks start between 60 L/min and 900 L/min. The diposable mouthpiece were used and mouthpiece was washed and sterilized for each subject. No nose clips were used.

Before the procedure, the purpose and method of the assessment is explained to the participants. Before measuring, the participants took a short deep breath. All participants were tested standing up.

After the actual performance, the participants were asked to take a deep breath and then blow into the mouthpiece with their best effort. Read the results from the scale. Take at least 3 readings and save the best score. Data from all participants were analyzed and the mean value of trunk to leg length was evaluated with body length, leg length and peak expiratory flow.

Relationship of trunk to leg ratio with peak expiratory flow rate was evaluated. The trunk length and leg length were also correlated with peak expiratory flow rate. The aim of this study was to analyze the relationship between trunk to leg length ratio and peak flow rate in children to better understand the relationship between trunk to-leg length ratio and PEFR and possibly identify those at risk for respiratory diseases.

AIMS & OBJECTIVES

To study the relationship between trunk leg ratio and peak flow rate in young healthy girls, to help identify those with high chance of respiratory disease. And to find effectiveness of trunk leg ratio as an indicator or factor that effects peak flow rate or lung function.

Hypothesis

Experimental Hypothesis

There is relationship between trunk leg length ratio and peak expiratory flow rate in young healthy girls.

Null Hypothesis

There is no correlation between trunk leg length ratio and peak expiratory flow rate in young healthy girls.

REVIEW OF LITERATURE

Thakur Shailesh Kaumar Singh (2014) conducted a study to correlate age, height and weight with PEFR in study population. This study was conducted on 254 subjects of 10-14 years of age. Height and weight were measured according to a standardized protocol. All the parents filled a self-administered questionnaire to obtain general information and disease history of the participant. PEFR was measured in all subjects. It included 152 boys and 102 girls. There was significant difference in height, weight and PEFR in all age groups. All parameters were higher in boys as compared to girls. Girls achieved earlier pubic hairs and breast development than males. The study concluded PEFR is indicator for respiratory diseases commonly seen in children. It is positively correlated with age, height and weight of subjects.

Bin Dong and Jun Ma (2016) conducted a study to check leg to trunk ratio and the risk of hypertension in children and adolescents. It was a population based study. A larger LTR was associated with decline levels of BP across the height and age spectrum in both sexes. The study concluded association of low LTR with elevated risk of high blood pressure in youths.

Tipnis NA Shah S. (2016) conducted a study to evaluate effect of body positions on peak expiratory flow rates in adult asthmatics. A cross sectional study was performed in 20 asthmatic subjects aged 18-50 years in whom correct instructions for PEF technique were given according to guidelines of National Institute of Health. The study concluded that there is a significant difference between PEFR values in standing, sitting with slump forward 100 and lying back 450 position. Standing position is the best option for adult asthmatics to measure their PEF values as it generated maximum PEF.

Jena et al. (2017), Studied Peak expiratory flow rate and its relation to body mass index in young adults. This was a comparative study in which healthy young adults were recruited as the subjects. Total 105 subjects were selected which included 56 male and 49 female. All subjects were between ages 18 and 24 years. This study concluded that PEFR declines with increase in BMI, and there is negative correlation between BMI and PEFR.

Harpreet Kaur et al. (2013), a study was conducted to assess variations in the Peak Expiratory Flow Rate with Various Factors in a Population of Healthy Women of the Malwa Region of Punjab. This study generated the preliminary values of PEFR for the women of the Malwa region of Punjab, India.

Jayapal J. (2016) studied postural variation in peak expiratory flow rates in healthy adult female subjects in South India. The study concluded that in postural changes, PEFR measurements significantly differ based on whether the measurements are taken in the standing or in the lying posture in healthy participants. The effect of posture may be of importance in recording PEFR and changing to a better posture may be especially useful for those patients with weak expiration.

Adama et al. (2019), The Relationship between Trunk Leg Ratio and Peak Expiratory Flow Rate was studied. This study was an analytical cross-sectional design, involving 83 Level 200 MBBS/BDS students of Bayero University. The study founded Significant correlation between the TLR, which is an anthropometric parameter and the PEFR which is an important diagnostic tool in determination of some types of respiratory diseases. This relationship signifies that the taller the person, irrespective of the trunk length, the higher the PEF.

Gupta et al. (2013) Studied Peak expiratory flow rate in highlander children. The study suggests that besides anthropometric and socio-economic factors, altitude is an important determinant of lung function.

Jena SK, Mishra AK, (2017) Studied relation of peak expiratory flow rate to body mass index in young adults. In this study 56 male and 49 female were recruited. The study concluded that PEFR declines with increase in BMI, and there is negative correlation between BMI and PEFR.

Manjunath CB (2013), studied the PEFR in healthy rural school going children (5-16 years) of belluar region for construction of nomogram.

Wallace et al (2013) studied PEFR in bed. compared 3 positions. Healthy adults performed the PEF maneuver in random order, standing, lying back at and 45° angle on pillows, and sitting, slumped forward 10° with legs extended. PEF was recorded for 3 attempts in each of the 3 positions. The study concluded that clinicians should ensure that PEF is obtained with patients out of bed and in the standing position.

Dr H Marike Boezen (1999) studied effect of ambient air pollution on upper and lower respiratory symptoms and peak flow in children. Study concluded that there were no consistent positive or negative associations between increased air pollution and prevalence of respiratory symptoms or decrease in peak expiratory flow in the other three groups of children.

Brendan Morrow (2019) studied the utility of using peak expiratory flow and forced vital capacity to predict poor expiratory cough flow in children with neuromuscular disorders. The aim of this study was to investigate the relationship between peak expiratory flow, forced vital capacity (FVC) and PCF in South African children with neuromuscular disorders. Study concluded that PEF and FVC may be surrogate measures of cough effectiveness in children with neuromuscular disorders.

David Kaminsky (2017), studied the fluctuation analysis of peak expiratory flow and its association with treatment failure in asthma. The study concluded that increased temporal self-similarity of more variable lung function (PEF) is associated with treatment failure, but the pattern of change in self-similarity leading up to treatment failure is variable across individuals.

Frischer et al (1993) conducted a study to assess relation between response to exercise and diurnal variability of peak expiratory flow in primary school children. The results showed that increased variability of PEF, as well as a response to exercise, was associated with respiratory symptoms, but only a response to exercise was closely associated with atopy (defined as a positive skin test to any of seven aero-allergens).

A.N. Aggarwal et al (2000) studied diurnal variation in peak flow rate in healthy young adults. The results concluded that there was no significant relationship between diurnal variation in peak flow rate of both sexes.

Mahmoud Zureik et al (2001) studied association between peak expiratory flow and the development of carotid atherosclerotic plaques. The study concluded that reduced lung function predicts the development of carotid atherosclerosis in elderly subjects. The nature of these associations remains largely unknown and merits further investigations. Nevertheless, assessment of lung function, which is simple and inexpensive, could help identify a population at high risk of atherosclerosis development and coronary heart disease.

M.B. Dikshit (2004) evaluated a set of regression equations for use for the Indian population.

Hegewald et al (1995) studied intra individual Peak Flow Variability. The study concluded that estimates of intra individual variability in healthy subjects are generally lower than those previously reported. Meter variability accounts for only a small part of total intraindividual variability. The 95th percentile data suggest that a fall in PEF of 6 to 8% in adults and 9 to 10% in youths would be statistically significant.

Ravi Vaswani (2005) evaluated factors affecting peak expiratory flow in healthy adults. The study concluded that position of the subject and application of nose clip has no significant impact on PEF measurement.

Reddel et al (2004) studied the personal best peak flow that can be determined for asthma action plans. The study showed that the personal best PEF is a useful concept for asthma self-management plans when determined as the highest PEF over the previous 2 weeks. With twice daily monitoring, personal best PEF reaches plateau levels after only a few weeks of corticosteroid treatment.

Chong et al (2000) studied peak expiratory flow rate and premenstrual symptoms in healthy non asthmatic women. The results showed intra subject and diurnal variability in PEFR are minimal in non asthmatic women; similarly, inter subject variability is relatively low. The menstrual cycle appears to have little effect on PEFR in healthy non asthmatic Asian women.

Debray et al (2008) conducted a comparative study of the peak expiratory flow rate of Indian and Nepalese young adults in a teaching institute. The analysis showed that height is the best predictor for PEFR in the present study.

A Bheekie (2001) analyzeded Peak expiratory flow rate and symptom self monitoring of asthma initiated from community pharmacies. The result showed PEFR self monitoring proved to be a more useful asthma tool than symptom self monitoring. Patients applying symptom monitoring tend to under estimate the severity of their condition and use medication inappropriately. Active involvement of community pharmacists in facilitating and reinforcing out patient self monitoring would help to optimize asthma management.

Enright & McClelland (2001) conducted a study to correlate peak expiratory flow liability in elderly persons. It was concluded that PEF lability at home is highly successful in elderly persons. PEF lability $\geq 30\%$ is abnormal in the elderly and is associated with asthma.

Harirah et al (2005) studied effect of gestational age and position on peak expiratory flow rate. This was a longitudinal study. The concluded that PEFR measurements are affected by maternal position and advancing gestational age, especially in the supine position. Adjustment of patient's flow rate in relation to gestational age and maternal position is recommended, especially in pregnant women with asthma.

Maccoy et al (2010) evaluated peak expiratory flow monitoring and compared sitting versus standing measurements. The results concluded that PEF measurements do not significantly differ based on sitting or standing measurements among healthy participants. Based on the results of this study it may not be necessary for the patient to stand while performing PEF measurements. Further study among patients with asthma is warranted.

Trevisan et al (2019) studied a cross-Sectional and longitudinal Associations between Peak Expiratory Flow and Frailty in Older Adults. The findings suggested that PEF is a marker of general robustness in older adults, and its reduction exceeding that expected by age is associated with frailty development.

Jéssica Perossi (2019) analyzed peak expiratory flow in obese subjects in different positions. The study suggested that the PEF of healthy obese are similar in the standing and seated positions. The PEF decreases in the lying positions, except for the LL, that could be used as an alternative for measurements.

Kimberly Shiu (2017) studied the trunk-to-leg ratio in regions of extreme stunting prevalence in the Western Highlands of Guatemala. The results showed a stunting prevalence increases in a population, the median trunk-to-leg ratio initially falls to the 0.82 range and stabilizes thereafter, but in isolated third degree stunting, the median trunk-to-leg ratio reaches 0.85. children.

S Venkateswara Babu (2019) studied the association of overweight and pefr among children. The study showed a significant difference in the PEFR rate between obese, overweight and normal groups where higher PEFR has been reported on obese than normal. Excess weight directly and positively affects the PEFR.

Sion Jo et al. (2019) studied change in peak expiratory flow rate after the head-tilt/chin-lift maneuver among young, healthy, and conscious volunteers. The study results showed that PEFR increased by 9.6% after the HT/CL maneuver in young conscious subjects, but some subjects showed decreased PEFR after the HT/CL maneuver.

Yun-Chul (2006) conducted a study to assess lung function decrement associated with metal components in particulate pollutants. This study demonstrated that particulate pollutants and metals such as manganese and lead in the particles are associated with a decrement of PEFR.

Pallavi Chitnis (2018) conducted a correlative study of the different grades of BMI with PEFR in young adults. The result show there is increase in PEFR in overweight as compared to normal which means increased in BMI causes increase in muscle strength. In obese group PEFR is less as compared to normal group.

METHODOLOGY

Study Design

It is a cross sectional observational study to study relationship between trunk leg ratio and peak expiratory flow rate.

Study Setting

The study was conducted at Rajkiya Purva Madhyamik Vidyalaya, Rajpur Road, Dehradun; Eklavya coaching centre, turner road, Dehradun; Nari /kishori niketan Kendra, near doon university, Dehradun.

Study Duration

The study was performed over a period of two weeks.

Subjects

80 females between 10-15 years of age with BMI (18.4-24.9 kg/m^2) value were included.

Criteria for Inclusion and Exclusion

Inclusion Criteria:

Age 10-15 years

Females

BMI = 18.5–24.9kg/m^2

Exclusion Criteria:

Volunteers with Cardiorespiratory disease (Asthma, Chronic Bronchitis, Cystic Fibrosis, Congenital Heart Disease).

Neurological disease (Cerebral Palsy, Muscular Dystrophy, Epilepsy, Encephalopathy) were excluded.

Volunteers whose BMI was 25.0-29.9 or above (overweight) and less than 18.4 (underweight) were excluded.

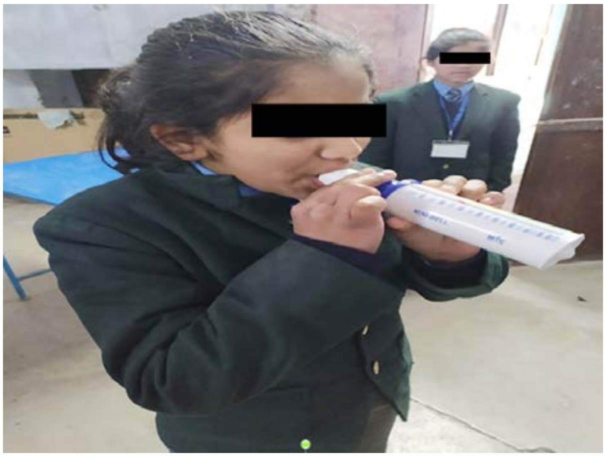
Materials used in the Studys

Pencil

Measuring Tape

Weight Machine

Chair



Peak Flow Meter.

PROCEDURE

Sampling and Data Collection

A total of Eighty (80) students were selected as per exclusion and inclusion criteria. The procedure was explained to the volunteering subjects and their wardens/guardians signed the consent form.

For calculation of BMI, NCBI calculator was used (BMI = weight in kg/height in m^2). BMI was measured to the nearest kg.

A measuring tape was used in measuring the Trunk length and Leg length and a mini peak flow meter was used in measuring Peak Expiratory Flow Rate.

Determination of Trunk-Leg Ratio

In this study, the trunk-leg ratio was determined as follows; the subject was asked to stand in an anatomical position and a measuring tape was used to measure the trunk-length which was measured from the shoulder to the summit of the iliac crest measurement was taken to the nearest cm. With the subject still in anatomical position, the leg length was measured which was gotten from the summit of the iliac crest down to the floor. The Trunk-leg ratio was obtained by dividing the trunk length with the leg length.

Determination of Peak Expiratory Flow Rate

PEFR (L/min) was evaluated with the brand name device Mini Bell peak flow meter with a range of 60 to 900 L/min. The PEFR was obtained by a forced exhalation maneuver beginning with a maximum inhalation. Subjects were evaluated in a standing position. Prior to the evaluation, the device was described to the subjects. Afterwards, the assessment was carried out with the highest value recorded of the three attempts. The participants were asked to stand erect holding. Peak Expiratory Flow Meter with one hand and was asked to maximally breath in and then wrap the mouth around the mouth piece of the Peak Flow Meter then expire maximally into the Peak Flow Meter.

RESULTS

The study was analysed by Pearson's Moment of Correlation and independent sample t-test and the test results showed negative correlation between PEFR and trunk to leg length ratio (0.30). A moderate correlation was found between leg length and PEFR (0.58). Correlation between PEFR

Table 1: Mean value

Variables	Number (No.)	Mean ± STD
PEFR (L/min)	80	257.5± 65.61
Trunk length	80	337.975±3.99
Leg length	80	72.225±10.08
Trunk leg ratio	80	0.525±0.09

Table 2: R value and pearson correlation coefficient

Variable	No.	R-value
PEFR/Trunk leg ratio	80	-0.3083
PEFR/Trunk length	80	0.472479268
PEFR/Leg length	80	0.584613

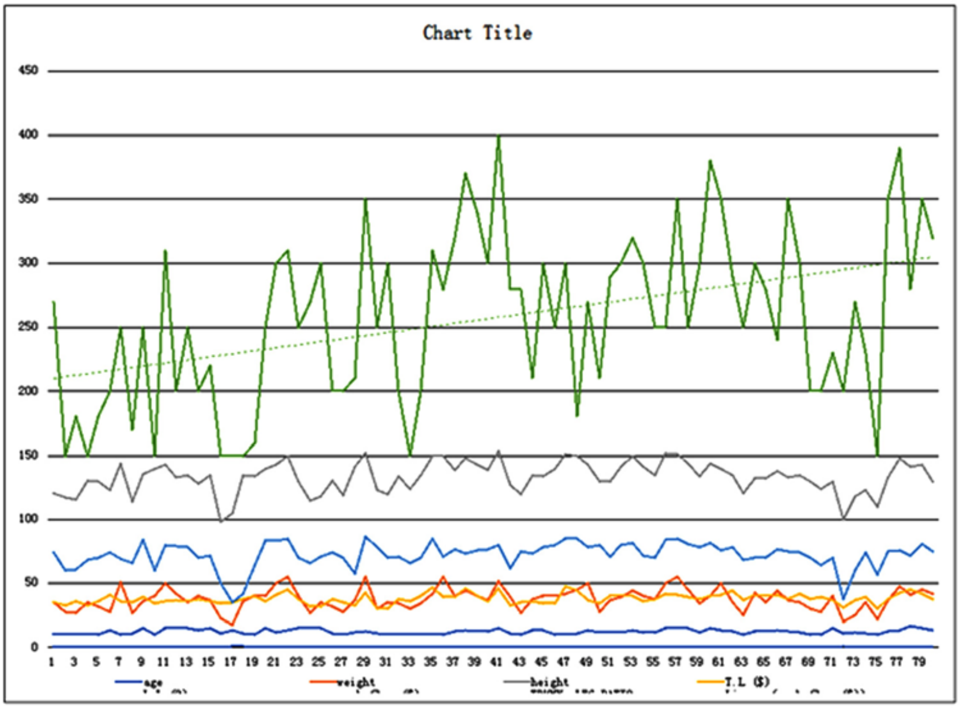


Fig. 1: Line graph

Table 3: Master Table

S. No.	Age	Weight	Height	T.L (cm)	L.L (cm)	Peak flow (L/min)
1	10	35	121	35	74	270
2	10	28	117	33	60	150
3	10	27	116	36	61	180
4	10	35	131	33	68	150
5	10	32	130	36	70	180
6	14	28	123	41	74	200
7	10	51	144	36	69	250
8	11	27	114	35	66	170
9	15	36	136	39	84	250
10	10	40	140	34	60	150
11	15	50	143	36	80	310
12	15	42	133	37	79	200
13	15	35	135	36	78	250
14	14	40	128	38	70	200
15	15	37	135	36	72	220
16	11	23	98	34	50	150
17	14	18	105	35	35	150
18	11	36	135	38	42	150
19	10	40	134	40	64	160
20	15	40	140	36	83	250
21	12	50	143	41	83	300
22	14	55	150	45	85	310
23	15	40	130	38	70	250
24	15	27	115	32	66	270
25	15	35	118	32	71	300
26	11	32	131	38	74	200
27	10	28	119	35	70	200
28	12	37	141	33	58	210
29	13	55	152	43	87	350
30	11	30	123	30	78	250
31	10	35	120	30	70	300
32	10	34	134	38	71	200
33	10	30	124	36	66	150
34	10	34	135	40	70	200
35	10	42	150	47	85	310
36	10	55	150	39	71	280
37	13	40	139	39	77	320
38	14	44	148	46	73	370
39	13	40	143	40	76	340
40	13	37	139	36	77	300
41	15	52	154	46	80	400
42	11	39	127	33	62	280
43	10	27	120	35	75	280
44	14	38	135	36	73	210
45	14	40	134	34	78	300

Table cont...

46	10	40	140	34	80	250
47	10	42	151	48	85	300
48	11	45	150	44	85	180
49	14	50	143	37	78	270
50	12	28	130	34	80	210
51	12	37	130	40	71	290
52	12	39	141	40	80	300
53	14	44	150	40	82	320
54	12	40	141	36	72	300
55	12	38	135	38	70	250
56	15	50	152	42	84	250
57	15	55	151	41	85	350
58	15	45	144	39	81	250
59	12	34	134	38	78	300
60	15	40	144	40	82	380
61	14	50	140	41	76	350
62	13	35	135	44	78	290
63	10	25	121	37	68	250
64	13	43	132	41	70	300
65	13	35	132	40	70	280
66	14	44	138	41	77	240
67	13	37	133	38	75	350
68	12	35	135	42	74	300
69	10	30	130	38	70	200
70	10	28	124	39	64	200
71	15	40	130	37	70	230
72	11	20	100	31	38	200
73	12	25	118	37	60	270
74	11	35	123	39	74	230
75	10	22	110	30	57	150
76	13	37	133	38	75	350
77	14	48	148	43	76	390
78	17	41	141	45	72	280
79	15	45	143	42	81	350
80	14	42	130	38	75	320

and tunk length was very low (0.47).

Statistical Analysis

DISCUSSION

This study was conducted to find a relation between trunk to leg ratio and peak expiratory flow rate. The young girls between age 10-15 years were taken and their trunk length and leg length was measured and their ratios were obtained. A peak flow meter was used to asses the PEFR while standing erect. Peak flow rate was obtained in Standing position, as it is the best option for as it generated maximum PEF.[7] Peak expiratory flow rate (PEFR) is a convenient and reliable measurement in diagnosing and monitoring the progress of airflow limitation and evaluating the response to treatment. There is a relationship between height, weight, chest circumferences with PEFR. PEFR is an important diagnostic and prognostic tool of lung functions which predicts variations in airflow.[8]

In this study a relationship between TLR and PEFR was obtained and in this study a negative correlation was found between both PEFR and trunk to leg ratio, which does relates with the findings of previous studies who found no significant relationship between Trunk-leg ratio and PEFR.[3]

JUN MA, *et al* study aimed to evaluate the association between ratio of height components, leg-to-trunk ratio (LTR) and high blood pressure (HBP) in Chinese children and adolescents aged 9–17. In this study, Larger LTR was associated with declined levels of BP across the height and age spectrum in both sexes. Low LTR was associated with elevated risk of HBP in youths. Their findings supported use of LTR to identify children and adolescents at elevated risk of hypertension in early life.

Peak expiratory flow rate (PEFR) is the maximum flow rate generated during a forceful exhalation, starting from full lung inflation. PEFR primarily reflects large airway flow and depends on the voluntary effort and muscular strength of the patient. PEFR is effort dependent and it and the normal range of the PEFR is related to factors such as age, height, weight, gender, race and the environmental conditions.[14] A study showed the variations of the PEFR with the age, height, weight, Body Surface Area (BSA) and the Body Mass Index (BMI) in healthy women of the Malwa region of Punjab, who were living within similar socio-cultural environments and were engaged in similar forms of physical activities. Study showed that there was an increase in the PEFRs of the study subjects with an increase in their heights.[2] A study showed that PEFR declines with increase in BMI, there is evidence that obesity has a link to bronchial hyper responsiveness.[10]

The height plays a major role in peak flow rate and other spirometric values.[13] Yanhonglu, *et al* predicted pef value for Chinese students, in this study height was the barometric variable with greatest correlation to PEF for both sexes.[12]

In this study trunk-leg ratio (TLR) was used for better understanding of the association between Trunk-leg ratio and PEFR to identify those with high chances of respiratory diseases. Thus, young children with icresaed BMI or living in polluted environment are at high chance of getting cardiorespiratory disease.

Limitations

1. The study consisted of a small number of subjects.
2. PEFR and more anthropometric parameters should be considered in children.
3. Other components should also be measured eg. FEV1.

CONCLUSION

This study concluded that there is no correlation between trunk leg length ratio and peak flow rate in young girls. The results of this study revealed moderate correlation between leg length and PEFR among the normal BMI females, also revealed no relation between the trunk length and PEFR.

Future Study

The findings suggest that further studies should look into relationship between PEFR and more anthropometric parameters.

SUMMARY

Title of Study:

To Study Relationship between trunk Leg ration and Peak Flow Rate in young girls.

Background

Being an important physiological and clinical tool in assessing respiratory conditions, it is common knowledge that Peak expiratory flow rate (PEFR) may be affected by some factors affecting the normal function of the respiratory system. Such factors include the body constitution such as height, built, sex, age etc.; The trunk-leg ratio (TLR) was used in apparently normal young adults. A better understanding of the association between Trunk-leg ratio and PEFR may identify those with elevated risk of respiratory diseases.

Objectives:

To get a better understanding of the association between Trunk-leg ratio and PEFR that may help identify those with high chance of respiratory diseases.

Materials and Method:

A total of Eighty (80) students were selected as per exclusion and inclusion criteria. For calculation of BMI, height and weight was used (BMI = weight in kg/height in m^2). A measuring tape was used in

measuring the Trunk length and Leg length and a peak flow meter was used in measuring Peak Expiratory Flow Rate.

Conclusions

There is negative correlation between PEFR and trunk to leg ratio in young girls with normal BMI.

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Original Article

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Effectiveness of Muscle Energy Technique on Pain, Range of Motion, Proprioception, Muscle Strength & QOL in Diabetic Frozen Shoulder Conditions

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ABSTRACT

Introduction: The term "frozen shoulder" was first introduced by Codman in 1934. He described a painful shoulder condition of insidious onset that was associated with stiffness and difficulty sleeping on the affected side. Codman also identified the marked reduction in forward elevation and external rotation that are the hallmarks of the disease (Richard Dias *et al*, 2005).

Aims and Objectives: To evaluate the effectiveness of Muscle Energy Techniques along with conventional Therapy on Pain, ROM, Muscle Strength, Proprioception, Disability, Anxiety & Depression, quality of life and Mindfulness in patients with diabetic frozen shoulder.

Methodology: 31 Patients were treated with Muscle Energy Technique (MET), Stabilization Exercise and Moist Heat Therapy. All the patients were selected after informed consent. These patients were interviewed by direct method. The patients were assessed in 0 (zero) week and reassessed in 4 (four) weeks and 8 (eight) weeks of treatment programme. Every 0 week 4 weeks and 8 weeks of treatment programme, pain, ROM, shoulder strength, shoulder Proprioception & disability were recorded. These treatment protocols will be given five days per week for eight weeks.

Conclusion: Our study concluded that Muscle Energy Technique (MET), Stabilization Exercise and Moist Heat Therapy (MHT) in Patients with Diabetic Frozen Shoulder showed significant improvement in pain, Range of motion muscular strength and joint position sense in 4th weeks & 8th weeks of treatment programme.

Keywords: Diabetic Frozen Shoulder; Muscle Energy Technique (MET); Stabilization Exercise; Moist Heat Therapy; Digital Inclinometer; Force Gauge & NPRS.

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INTRODUCTION

The term "frozen shoulder" was first introduced by Codman in 1934. He described a painful shoulder condition of insidious onset that was associated with stiffness and difficulty sleeping on the affected side. Codman also identified the marked reduction in forward elevation and external rotation that are the hallmarks of the disease. Long before Codman, in 1872, the same condition had already been labelled "periarthritis" by Duplay. In 1945, Naviesar coined the term "adhesive capsulitis" (Richard Dias *et al*, 2005).

Diabetic frozen shoulder is characterized by pain and severe limited active and passive range of motion of the glenohumeral joint, particularly external rotation. Diabetes is frozen shoulder is due to the effects on collagen in the shoulder, which holds the bones together in a joint. Collagen gets triggered by the presence of high blood sugars. Interestingly, collagen gets sticky when sugar molecules become attached, leading to restricted movements and shoulder starting to stiffen (Cintia Garcilazo *et al*, 2010) (Fig. 1).

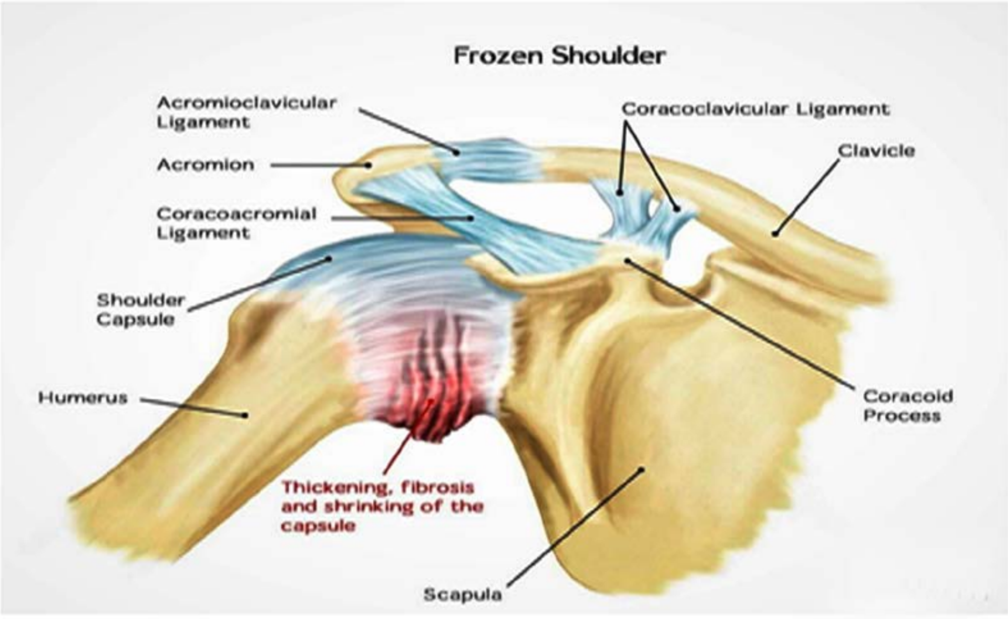


Fig. 1: Frozen Shoulder

The prevalence of adhesive capsulitis in patients with diabetes in India was reported to be 11%-29.61%, in Saudia Arabia 6.7%, in Iran 13.30%, in Finland 14%, in UK around 10.8%. Whereas other studies identified around 20% Australians, 38.6% Americans, 27% Indians and around 40% British reported diabetes in patients with adhesive capsulitis (Rita Rastogi, *et al.* 2014).

The etiology of periarthritis of the shoulder, however, is not clearly understood. Amongst the factors suggested are trauma myocardial infarction hemiplegia, pulmonary tuberculosis, thyrotoxicosis, cerebral tumor, and epilepsy. In this paper, an association of periarthritis of the shoulder with diabetes mellitus is described. The incidence of this condition in diabetic patients is compared with that in non-diabetic medical patients seen during the same period of time (G. C. Lloyd-Roberts, *et al.* 1959; J. F. Bridgman, *et al.* 1972).

The patho-physiology of idiopathic adhesive capsulitis is poorly understood. Most authors have reported various degrees of inflammatory changes in the synovial membrane. Adhesions between the shoulder capsule and the humeral head have been noted by some, but not all, authors. The optimum management of adhesive capsulitis has been the subject of great debate, particularly since the condition tends to resolve spontaneously over months to years (Simon Carette, *et al.* 2003).

Dr. Fred Mitchell Sr. developed the muscle energy technique. It is a non-invasive treatment that can be used to extend or stretch stiff muscles and fascia. MET primarily targets soft tissues, but it also significantly contributes to joint mobilisation, which enhances extensibility of muscle and increases range of motion of joints through a mechanism known as "enhanced tolerance to stretch." (Geetha Mounika Rayuduet *et al.* 2018).

The Numerical Pain Rating Scale (NPRS) is a subjective measure in which individuals rate their pain on an eleven point numerical scale. The scale is composed of 0 (no pain at all) to 10 (worst imaginable pain). It has been shown that a composite scoring system including best, worse, and current level of pain over the last 24 hours was sufficient to pick up changes in pain intensity with maximal reliability (Jensen, *et al.* 1999).

Range of motion (or ROM), is the linear or angular distance that a moving object may normally travel while properly attached to another. It is also called range of travel (or ROT). Range of motion refers to the distance and direction a joint can move between the flexed position and the extended position. (Wikipedia Range of motion, 2021).

A digital force gauge is a load cell (this is often combined with software and a display). A load cell is an electronic device that is used to convert a force into an electrical signal. Through a mechanical arrangement, the force being sensed deforms a strain gauge. The strain gauge converts the deformation (strain) to electrical signals. The software and electronics of the force gauge convert the voltage of the load cell into a force value that is displayed on the instrument. Test units of force measurements are most commonly newtons or pounds (Wikipedia Force gauge, 2020).

AIMS AND OBJECTIVES

To evaluate the effectiveness of Muscle Energy Techniques along with conventional Therapy on Pain, ROM, Muscle Strength, Proprioception, Disability, Anxiety & Depression, quality of life and Mindfulness in patients with diabetic frozen shoulder.

Hypothesis

Alternate Hypothesis

There will be significant differences of Muscle Energy Techniques along with conventional on Pain, ROM, Proprioception and muscle strength in patients with diabetic frozen shoulder.

Null Hypothesis

There will be not significant differences of Muscle Energy Techniques along with conventional on Pain, ROM, Proprioception and muscle strength in patients with diabetic frozen shoulder.

METHODOLOGY

Approval from the Synopsis Approval Committee (SAC) of SGRR University and Institutional Ethics Committee of Shri Guru Ram Rai Institute of Medical & Health Sciences, Patel Nagar, Dehradun was sought. The confidence level–95% and confidence interval-5% used to calculate sample size. In this study, Dehradun census (Uttrakhand) population (679,370 in 2018) was included (Census and Sample Survey, Dehradun 2018) (C. R. Kothari, 2004; Census and Sample Survey, Dehradun 2018).

In this study simple random sampling technique was used. These subjects were solicited from the Shri Mahant Indiresh Hospital, Department of Physiotherapy, Patel Nagar, Dehradun (Uttarakhand) and selected according to inclusion and exclusion criteria.

Inclusion Criteria: Patients which were diagnosed to suffer from Diabetic Frozen Shoulder, Patients with limited Range of motion of shoulder abduction, external rotation and flexion, All the patients (both males and females) between ages 40 to 70 years, All the subjects must have frozen shoulder for at least last 15 days, Affected shoulder must have not more than 90 degrees of flexion & abduction and 50% decreased external rotation & internal rotation as compared to normal side/ normal ROM values.

Exclusion Criteria: Subjects with Rotator cuff tears and other shoulder ligament injuries, History of any arthritis related to shoulder, RA shoulder secondary to fracture, dislocation, Reflex sympathetic dystrophy and neurological disorder, Malignancy, All the patients having any cervical or thoracic problem. If present must be treated first before including in the study, All the objects having any intra articular injection in the glenohumeral joint during last three months, Patients with fractured scapula, Any history of surgery on that shoulder and patients with tendon calcification, Patients with cervical rib, Diagnosed severely osteoporotic, Diagnosed Rheumatoid Arthritis, Diagnosed Osteoarthritis, Prolonged immobilization and Neurological/Hemiplegics. Those patients were also excluded from the study whose ROM; Flexion was more than 90°, Abduction more than 90°, Lateral rotation and medial rotation more than 50%. Outcome Measures Numeric Pain Rating Scale (NPRS), Digital Inclinometer, Force Gauge and Proprioception Measurement. (Table 1)

Table 1: Outcome Measures

Variables	Measurements
Pain	Numeric pain rating scale
Range of motion	Insize digital inclinometer
Muscle strength	Lutron force gauge
Shoulder proprioception	Joint position sense measurement

PROCEDURE

All the patients were selected after informed consent. These patients were interviewed by direct method. The patients were assessed in 0 (zero) week and reassessed in 4 (four) weeks and 8 (eight) weeks of treatment programme. Every 0 week 4 weeks and 8 weeks of treatment programme, pain, ROM, shoulder strength, shoulder Proprioception & disability were recorded. These treatment protocols will be given five days per week for eight weeks. 31 Patients were treated with Muscle Energy Technique (MET), Stabilization Exercise and Moist Heat Therapy.

Application Muscle Energy Techniques (MET) for Rotator cuff Muscle:

MET Treatment of Supraspinatus (Abduction O TO 15°):

Assessment for Shortness of Supraspinatus:

The therapist stands behind the seated patient, with one hand stabilizing the shoulder on the side to be assessed while the other hand reaches in front of the patient to support the flexed elbow and forearm. The patient's upper arm is adducted to its easy barrier and the patient then attempts to abduct the arm.

If pain is noted in the posterior shoulder region during this attempt this is diagnostic of supra spinatus dysfunction and, by implication because it is a postural muscle, of shortness.

Assessment for Supraspinatus Weakness

The patient sits or stands with arm abducted 15°, elbow extended. The therapist stabilizes the shoulder with one hand while the other hand offers a resistance contact which if forceful would adduct the arm. The patient attempts to resist this, and the degree of effort required to overcome the patient's resistance is graded as weak or strong.

The relative strength is judged and the method discussed by Norris (1999) should be used to increase strength (isotonic eccentric contraction performed slowly).

MET Treatment of Supraspinatus

The therapist stands behind the seated patient, with one hand stabilizing the shoulder on the side to be treated while the other hand reaches in front of the patient to support the flexed elbow and forearm. The patient's upper arm is adducted to its easy barrier and the patient then attempts to abduct the arm using 20% of strength against therapist resistance. During this procedure, the patient inhales the air. After a 10 second isometric contraction, the patient exhales the air. The arm is taken gently towards its new resistance barrier into greater adduction, with the patient's assistance. Repeat several times, holding each painless stretch for not less than 20 seconds (Leon Chaitow, *et al.* 2006) (Fig. 2).

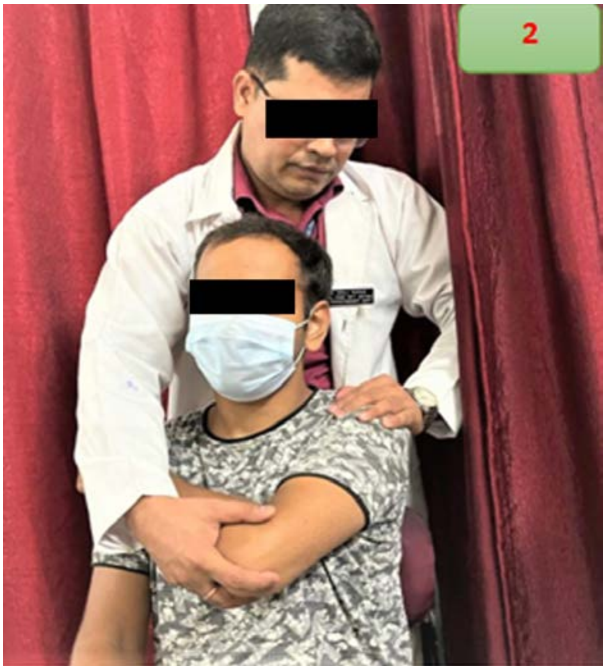


Fig. 2: MET treatment of supraspinatus

MET of Infraspinatus (External Rotator)

Infraspinatus Shortness test

1. The patient is asked to reach upwards, backwards and across to touch the upper border of the opposite scapula, so producing external rotation of the humeral head. If this effort is painful Infraspinatus shortness should be suspected.
2. The patient supine, upper arm at right angles to the trunk, elbow flexed so that lower arm is parallel with the trunk, pointing caudad with the palm downwards. This brings the arm into internal rotation and places Infraspinatus at stretch. The therapist ensures that the shoulder remains in contact with the table during this assessment by means of light compression.

If Infraspinatus is short, the lower arm will not be capable of resting parallel with the floor, obliging it to point somewhat towards the ceiling.

Assessment for Infraspinatus weakness

The patient is seated. The therapist stands behind. The patient's arms are flexed at the elbows and held to the side, and the practitioner provides isometric resistance to external rotation of the lower arms (externally rotating them and also the humerus at the shoulder). If this effort is painful, an indication of probable Infraspinatus shortening exists. The relative strength is also judged. If weak, the method discussed by Norris (1999) (see Ch. 3) should be used to increase strength (isotonic eccentric contraction performed slowly). Force should always be built slowly and not suddenly.

MET Treatment of Infraspinatus:

The patient was positioned in supine lying on the examination table and shoulder abducted to 90 degree and elbow flexed to 90 degree respectively. The therapist will be passively internal rotated the shoulder until the first barrier of movement is reached. Then the patient will be asked to perform a 5 second isometric hold at 25% of his/her maximal voluntary contraction in the direction of external rotation, against an opposing force provided by the examiner at the distal forearm. During this procedure, the patient inhales the air. After a 05 second isometric contraction, the patient exhales the air. Following the contraction the patient will be instructed to relax and the therapist took the shoulder to new internal rotation range and the stretch was applied for 30 seconds and the same method is performed again (Leon Chaitow, *et al.* 2006; Geetha Mounika Rayudu, *et al*. 2018; Stephanie D. Moore, *et al.* 2011) (Fig. 3).

Fig. 3: MET treatment of Infraspinatus

MET of Subscapularis (Internal Rotator & Adductors)

Subscapularis Shortness Test:

The patient was lying supine with the arm abducted to 90°, the elbow flexed to 90°, and the forearm in external rotation, palm upwards. The whole arm was resting at the restriction barrier, with gravity as its counter weight. If subscapularis is short the forearm was unable to rest easily parallel with the floor but was somewhat elevated.

Care is needed to prevent the anterior shoulder becoming elevated in this position (moving towards the ceiling) and so giving a false normal picture.

Assessment for Subscapularis weakness:

The patient was lying prone with humerus abducted to 90° and elbow flexed to 90°. The shoulder was in internal rotation so that the forearm is parallel with the trunk, palm towards ceiling. The therapist stabilized the scapula with one hand and with the other applies pressure to the patient's wrist and forearm as though taking the humerus towards external rotation, while the patient resists. The relative strength was judged and the method discussed by Norris (1999) should use to increase strength (isotonic eccentric contraction performed slowly).

MET Treatment of Subscapularis (Internal Rotation)

The patient was positioned supine on the treatment table with the shoulder and elbow, at 90 degree of abduction, flexion and the forearm in external rotation, palm upwards. The shoulder was stabilized at the acromion process with one hand, and the other hand will be used to passively move the arm into internal rotation until the first barrier of motion was reached. The patient was then instructed to perform a 7-10 second isometric contraction of approximately 25% maximal effort in the direction of external rotation, against an opposing force provided at the distal forearm. During this procedure, the patient inhales the air. After a 7-10 second isometric contraction, the patient exhales the air. Following the contraction, the patient will be instructed to internally rotate the arm toward the ground as a 30 second active assisted stretch will be applied. The patient was instructed to relax, and a new movement barrier was then engaged. This protocol was performed for a total of 3 repetitions. (Stephanie D. Moore *et al* 2011). This lengthens the external rotators thus increasing the internal rotation range of motion (Leon Chaitow, *et al.* 2006; Sonakshi Sehgal, *et al.* 2016; Stephanie D. Moore, *et al.* 2011).

The MET to shoulder was given for 5 repetitions per set for 3 sets and the treatment procedure performed 3 sessions in a week for 8 weeks (Leon Chaitow, *et al.* 2006; Geetha Mounika Rayudu *et al.* 2018) (Fig. 4).

Fig. 4: MET treatment of subscapularis (Internal Rotation)

SHOULDER STABILIZATION EXERCISE

After manual therapy intervention, the exercises were incorporated for the training of shoulder flexors, abductors and external and internal group muscle.

Shoulder Stabilization Exercise for Abductors (Supraspinatus and Middle Deltoid)

1. **Shoulder Stabilization Exercise for Supraspinatus**

Patient will be sitting position. The patient pushing out against the wall. Initially the manoeuvres are done with the shoulder in less than 0 to 10° of abduction (Fig. 5).

2. **Shoulder Stabilization Exercise for Deltoid**

Patient will be sitting position. The patient pushing out against the therapist hand. Initially the manoeuvres are done with the shoulder in above than 90° of abduction (S.B. Brotzman *et al*. 1996; T. M. S kirven, *et al.* 2011) (Fig. 6).

Fig. 5: Shoulder Stabilization Exercise for Supraspinatus

Fig. 6: Shoulder Stabilization Exercise for Supraspinatus and Deltoid (5 & 6).

3. **Shoulder Stabilization Exercise for External Rotators (Infraspinatus, Teres Minor, Posterior Deltoid).**

Patient will be stand with the involved side of his body against a wall or therapist hand. Bend your elbow to 90° and told the patient performed external rotation against the wall. The patient arm should not move (S.B. Brotzman *et al.* 1996; Shoulder Strengthening Exercises 2010).

4. **Shoulder Stabilization Exercise for Internal Rotators (Subscapularis and anterior deltoid)**

Patient will be stand with the involved side of his body against a wall. Bend your elbow to 90° and told the patient performed internal rotation against therapist hand. The patient arm should not move (S.B. Brotzman 1996; American Academy of Orthopaedic Surgeons 2017; T. M. S kirven, *et al.* 2011).

5. **Shoulder Stabilization Exercise for scapular muscles.**

❖ ***Patient Position and Procedure:*** standing with shoulder flexed 90° and hand supported against a wall. The patient is try to touch the wall by upper trunk.

Progression: have the patient quadruped position with both hands on a stable surface, so that one extremity bears the body weight and stabilizes against the shifting load to increase Serratus activity and lower trapezius activity respectively.

❖ ***Scapular Elevation/Depression:*** Place your top hand superiorly and the other hand inferiorly around the scapula to provide manual resistance.

- ***Scapular Protraction/Retraction:*** Place your top hand along the medial border and the other around the coracoid process to provide resistance.
- ***Scapular Upward and Downward Rotation:*** Place one hand around inferior angle and the other hand around the acromian and coracoid process to provide resistance (C. Kisner, *et al*. 2018).

The exercise will be performed 8 to 15 repetitions for 3 sets only 5 times/week for 8 weeks. It is performed with 5 to 10 second hold in each repetition a break of 1 min after each set (S.B. Brotzman, *et al.* 1996; Ju-hyun Lee, *et al.* 2018).

Moist Hot Pack (MHT)

The subject will be asked to lie down in a supine position and the shoulder is placed in the neutral position. The hot pack (standard size which had been stored in a hydro collator tank of 74.5-80 °C). Moist heat pack will be wrapped in towel with three to four folds over the affected shoulder. The pack was left in place for 10 to 15 minutes (Dhara N. Panchal, *et al.* 2015; Kumar Neeraj, *et al.* 2016) (Fig. 7).

Fig. 7: Application of Moist Heat Therapy in Shoulder joint

RESULTS

Total 31 patients were included in the study by simple random sampling method. The data were analyzed using the statistical software SPSS 15 version. The result was analyzed by Repeated Measure ANOVA for within group in 0 week, 4 week & 8 week of treatment. Pain was measured by NPRS, Range of Motion was measured by Digital

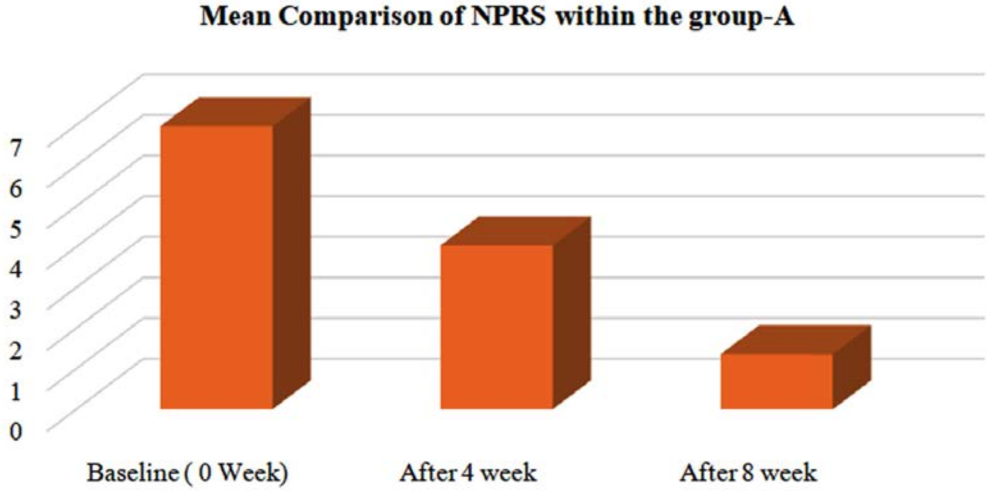
Inclinometer, Shoulder Proprioception was also measured by Digital Inclinometer, Muscle strength was measured by Force Gauge and Quality of Life was measured by WHOQOL.

Measurement of Numeric Pain rating scale within the Group-A:

Analysis of the Numeric pain rating scale within groups was done usingrepeated measure ANOVA test. The differences in NPRS scores from Baseline (0 Week), 4 week & 8 week for Group Ashowed highly significant reduction of pain (p-Value 0.001). (Table 2 & Graph 1).

Table 2: Mean Comparison within Group A of NPR Susing repeated measure ANOVA

Duration	Mean ±SD	F-Value	p- Value
Baseline (0 Week)	6.9677±.98265		
After 4 week	4.0323 ±1.13970	549.750	0.001
After 8 week	1.3548 ±.75491		



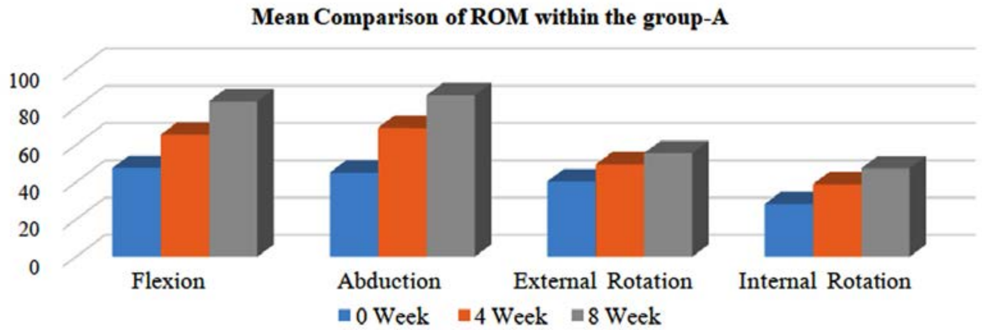
Graph 1: Comparison of Mean NPRS Score within Group A by repeated measure ANOVA

Measurement of Range of Motion scale within the Group-A:

Analysis of the difference in the ROM within groups repeated measure ANOVA test was used. The differences in Flexion, Abduction, External Rotation and Internal Rotation ROM at Baseline (0 Week), 4 week & 8 week for Group C showed highly significant improvement (p-Value 0.001) (Table 3 & Graph 2).

Table 3: Mean Comparison within Group A of RO Musing repeated measure ANOVA

Range of Motion (ROM)	0 Week	4 Week	8 Week	F - Value	p-Value
	(Mean ± SD)	(Mean ± SD)	(Mean ± SD)		
Flexion	47.4935 ±6.39244	65.4129 ±12.88854	83.3548 ±15.31533	156.075	0.001
Abduction	45.0613±9.10980	69.0968 ±12.32430	86.5323 ±13.36940	128.972	0.001
External Rotation	40.3161 ±3.95416	49.3935 ±5.72503	55.4032 ±5.06883	159.724	0.001
Internal Rotation	28.2097 ±3.73830	38.8484 ±3.41163	47.3806 ±3.45344	622.456	0.001



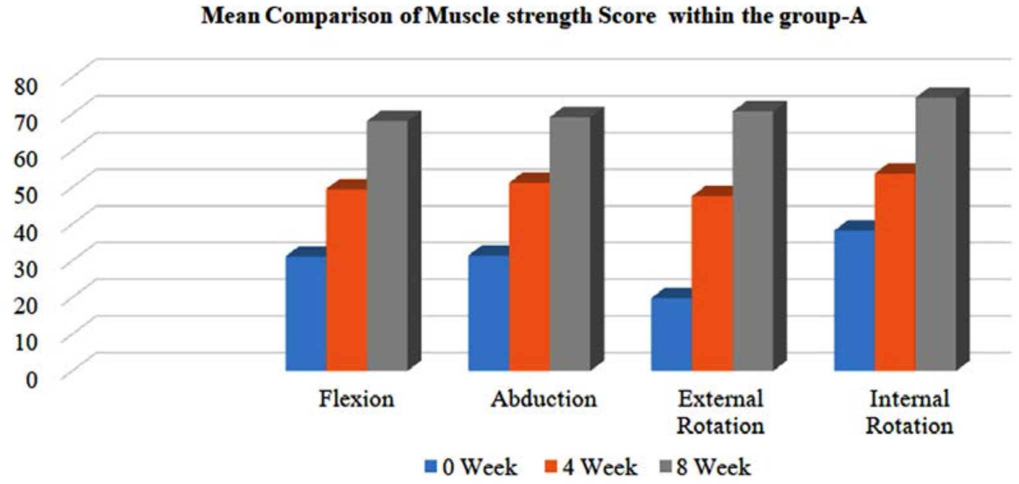
Graph 2: Comparison of Mean ROM within Group A by repeated measure ANOVA

Measurement of Measurement of Shoulder Strength within the Group-A:

Analysis of the difference in the Shoulder Muscle Strength within groups repeated measure ANOVA test was used. The differences in Flexion, Abduction, External Rotation and Internal Rotation Muscle Strength at Baseline (0 Week), 4 week & 8 week for Group A showed highly significant improvement (p-Value 0.001) (Table 4 & Graph 3).

Table 4: Mean Comparison within Group A of Shoulder Muscle Strength using repeated measure ANOVA

Strength Measurement	0 Week	4 Week	8 Week	F - Value	p-Value
	(Mean ±SD)	(Mean ±SD)	(Mean ±SD)		
Flexion	31.2077 ±10.69094	49.5223 ±7.31794	68.0210 ±8.95250	405.385	0.001
Abduction	31.4639 ±11.35258	51.2626 ±7.95710	69.1332 ±7.20782	319.822	0.001
External Rotation	19.8348 ±7.33526	47.5829 ±7.21948	70.6694 ±6.71968	958.858	0.001
Internal Rotation	38.1948 ±9.05161	53.7561 ±4.89439	74.4300 ±6.38854	337.739	0.001



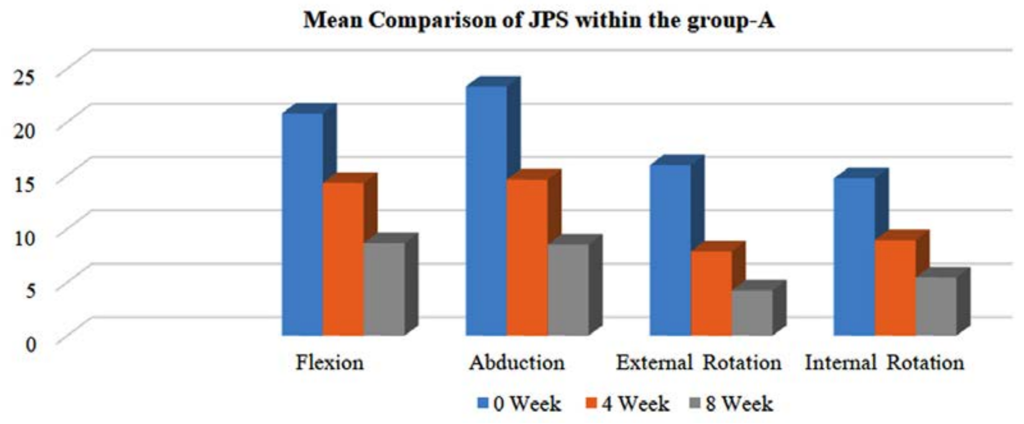
Graph 3: Comparison of Mean Muscle strength Score within Group A by repeated measure ANOVA

Measurement of Joint Position Sense Score within the Group-A

To analyze the difference in the Shoulder JPS within groups repeated measure ANOVA test was used. The differences in Flexion, Abduction, External Rotation andInternal Rotation JPS at Baseline (0 Week), 4 week & 8 week for Group Ashowed highly significant improvement of joint position sense and decrease error of shoulder joint (p-Value 0.001) (Table 5 & Graph 4).

Table 5: Mean Comparison within Group A of JPS using repeated measure ANOVA

Joint Position Sense	0 Week	4 Week	8 Week	F - Value	p-Value
	(Mean ± SD)	(Mean ± SD)	(Mean ± SD)		
Flexion	20.8000 ±4.95775	14.3000 ±3.44564	8.6667 ±2.98656	156.723	0.001
Abduction	23.3226 ±3.53447	14.6129 ±3.90451	8.5161±.3.07540	293.189	0.001
External Rotation	15.9677 ±2.94939	7.9032 ±2.21141	4.2258 ±1.96146	282.470	0.001
Internal Rotation	14.7097 ±3.23722	8.9355 ±2.64494	5.4516 ±2.32148	201.632	0.001



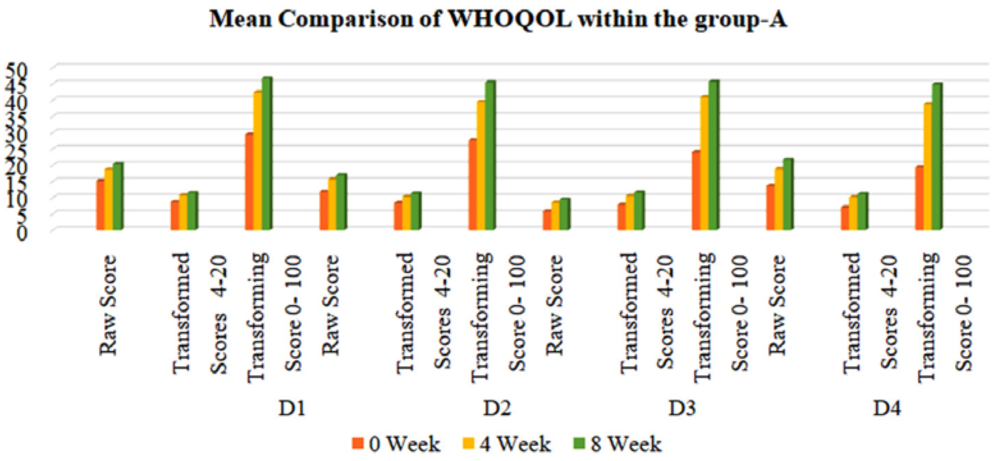
Graph 4: Comparison of Mean JPS Score within Group A by repeated measure ANOVA

Measurement of World Health Organization Quality of Life within the Group-A

Analysis of the difference in the WHOQOL scores within groups repeated measure ANOVA test was used. The differences in D1, D2, D3 & D4 Raw Score, Trans formed Scores (4-20) and Trans formed Scores (0-100) at Baseline (0 Week), 4 week & 8 week for Group C showed highly significant improvement (p-Value 0.001) (Table 6 & Graph 5).

Table 6: Mean Comparison within Group A of WHOQO Lusing repeated measure ANOVA

	Outcome Measures	0 Week (Mean ± SD)	4 Week (Mean ± SD)	8 Week (Mean ± SD)	F – Value	p- Value
	Raw Score	15.1935±2.1824	18.7097±1.50982	20.4194±1.50054	146.963	0.001
D1	Transformed Scores 4-20	8.7097±1.24348	10.7419±.89322	11.4516±.88840	103.406	0.001
	Transforming Score 0-100	29.4516±7.94078	42.3871±5.49350	46.7097±5.33038	107.894	0.001
	Raw Score	11.8710±1.58623	15.6452±1.53945	16.9677±1.35361	136.049	0.001
D2	Transformed Scores 4-20	8.4194±2.48696	10.2903±1.07062	11.2903±.82436	22.236	0.001
	Transforming Score 0-100	27.7097±15.4255	39.4839±6.75214	45.4839±5.07852	22.321	0.001
	Raw Score	5.8065±.98045	8.5161±2.51490	9.4839±3.09700	40.38	0.001
D3	Transformed Scores 4-20	7.8387±1.06761	10.5484±1.65002	11.6452±2.42966	112.785	0.001
	Transforming Score 0-100	24.0000±6.49615	40.9032±10.3773	45.6774±17.92277	62.36	0.001
	Raw Score	13.6452±1.76160	18.8387±3.45540	21.6774±2.15077	128.227	0.001
D4	Transformed Scores 4-20	7.0645±.92864	10.1613±.77875	11.1290±1.05647	324.359	0.001
	Transforming Score 0-100	19.3871±5.57182	38.7419±5.02638	44.8710±6.61182	332.833	0.001



Graph 5: Comparison of Mean WHOQOL Score within Group A by repeated measure ANOVA

DISCUSSION

The aim of this review was to understand the efficacy of MET on pain, ROM. MS. JPS, Anxiety & Depression, Quality of Life and Mindfulness to understand the differences within MET protocols in DFS.

Pain:

Pain was measured by Numeric pain rating scale. To analyze the difference in the NPRS scale within groups repeated measure ANOVA test was used. The difference in NPRS scores from Baseline (0 Week), 4 week & 8 week for Group C (MET), P-value are 0.001. Our study showed statistical improvement in pain score ($P< 0.05$) at 4 week and 8 week of treatment. Muscle energy techniques originally developed by osteopaths are a class of soft tissue manipulation technique which generally involves précisely directed and controlled patient initiated isometric and/or isotonic contractions to improve musculoskel *et al* function or to reduce pain. (Chaitow L, 2006). MET exercises spread synovial fluid stimulate tonically depressed joint mechanoreceptors and reduced pain (Narayan, *et al*. 2014). Muscle energy technique is effective on functional ability of shoulder in Frozen shoulder (Narayana, *et al.* 2014). Stephanie D. Moore in 2011 showed that pain reduction by MET was due to centrally mediated pain in hibitory mechanism and neuronal mechanism in dorsal horn is by neurological and tissue factors such as stimulation of low threshold mechanoreceptors which leads to possible gating effects and effect of rhythmic muscular contraction on interstitial and tissue fluid flow (Stephanie D. Moore 2011). MET improve the circulation and lymphatic flow and reduce pain (Joshua A. Waxenbaum, *et al* 2020).

Range of Motion (ROM)

Range of Motion was measured by Digital Inclinometer. To analyze the difference in the Flexion, Abduction, External Rotation & Internal Rotation ROM within groups repeated measure ANOVA test was used. The difference in ROM scores from Baseline (0 Week), 4 week & 8 week for Group-C (MET), P-value are 0.001. Our study showed statistical improvement in ROM score in the Flexion, Abduction, External Rotation & Internal Rotation ROM ($P< 0.05$) at 4 week and 8 week of treatment. Ewan Thomas, *et al.* 2019 stated high intensity contraction of MET could produce post synaptic inhibitory mechanisms, resulting in lower excitation of the cortical and α-motor neurons, thereby modulating stretch perception and increase that ROM and increased stretch tolerance. Stephanie *et al* (2011) stated muscle energy technique for the glenohumeral joint given immediate improvement in GHJ horizontal adduction and internal rotation ROM in asymptomatic collegiate baseball players. The increased active range of motion following MET may be due to various factors like neural, viscoelastic and thixotropic properties. After application of MET, musculo tendinous junction acts in a viscoelastic manner and lead to the properties of creep and stress relaxation (Geetha Mounika Rayudu *et al*. 2018). MET is effective in increasing the ROM of the glenohumeral joint. According to Chaitow L, 2006 the physiological mechanisms behind the changes in muscle extensibility produced by MET are reflex relaxation, viscoelastic or muscle property change, and changes to stretch tolerance a change to tolerance to stretching is most supported by the scientific literature (lean Chaitow). These mechanisms bring about a change in muscle physiology and hence lead to increased ROM at the joint. (Sonakshi Sehgal, *et al.* 2016). According to Lean Chaitow the physiological mechanisms behind the changes in muscle extensibility produced by MET are reflex relaxation, viscoelastic or muscle property change, and changes to stretch tolerance a change to tolerance to stretching is most supported by the scientific literature (lean Chaitow). These mechanisms bring about a change in muscle physiology and hence lead to increased ROM at the joint. (Sonakshi Sehgal *et al*. 2016).

Muscle Strength

Muscle Strength was measured by Lutron Force Gauge. To analyze the difference in the Flexion, Abduction, External Rotation & Internal Rotation Muscle Strength within groups repeated measure ANOVA test was used. The difference in Muscle Strength from Baseline (0 Week), 4 week & 8 week for Group C (MET), P-value are 0.001. Our study showed statistical improvement in Muscle Strength score in the Flexion, Abduction, External Rotation & Internal Rotation ($P< 0.05$) at 4 week and 8 week of treatment. MET lengthens and strengthens muscle by changing the viscoelastic property of the muscle, decreases local edema and reduces adhesions. (Ballantyne F, 2003). Roberts indicated the effects of MET as decreased pain, increased range of motion, decreased muscle tension and spasm, and increased strength. Another study by, Greenman (1989) depicts that Muscle Energy Technique helps to regain the mobility of the hypomobile joints by restoring normal length tension relationships which are shortened and by strengthening the weakened muscles and reduce edema by pumping action for lymphatic system (B. Chakradhar Reddy, Santosh Metgud, 2014).

Joint Position Sense Score (JPS)

Joint Position Sense Score (JPS) was measured by Digital Inclinometer. To analyze the difference in the Flexion, Abduction, External Rotation & Internal Rotation JPS within groups repeated measure ANOVA test was used. The difference in JPS scores from Baseline (0 Week), 4 week & 8 week post intervention for Group C (MET), P-value are 0.001. Our study showed statistical improvement in JPS score in the Flexion, Abduction, External Rotation & Internal Rotation and decrease the error of JPS (P< 0.05) at 4 week and 8 week of treatment. MET may also have physiological effects & involve a variety of neurological and biomechanical mechanisms that altered proprioception, motor programming and changes in tissue fluid that decrease the error of JPS (Fryer G. *et al*, 2003).

Quality of Life

Quality of Life was measured by WHOQOL. To analyze the difference in the QOL within groups repeated measure ANOVA test was used. The difference in QOL scores from Baseline (0 Week), 4 week & 8 week for Group C (MET), P-value are 0.001. Our study showed statistical improvement in QOL score (P< 0.05) at 4 week and 8 week of treatment.

The term frozen shoulder refers to a common shoulder condition characterized by the global restriction in the shoulder range of motion in a capsular pattern. The capsular pattern in the shoulder is characterized by most limitation of passive lateral rotation and abduction. Neviaser called it adhesive capsulitis, as he, under arthroscopy, observed that the capsule looked thickened and adhered to underlying bone and could be peeled off from the bone (Rizwan Haider *et al*. 2014).

In our study we used numerical pain rating scale (NPRS) for measurement of pain in Diabetic Frozen Shoulder Patients. Childs J *et al* in 2005 did study on responsiveness of the Numeric Pain Rating Scale in Patients with Low Back Pain. The NPRS shows adequate responsiveness for use both in the clinical and research settings. They found out that a two points change in NPRS represented clinically and meaningful changes in pain levels, though there were not much statistically significant difference. (Childs J *et al*, 2005).

In this study we found that in MET there are significantly increase joint AROM of Shoulder Joint than control group. Range of motion is the capability of a joint to go through its complete spectrum of movements. Measurement of range of motion can be used to evaluate available motion, determine joint stability, and determine soft tissue elasticity as well as response to therapy over time. Sandra Hudson, (2009). In our study for measure the joint ROM of shoulder joint we used Digital Inclinometer. Digital inclinometer is used for measuring active shoulder (Morey J. Kolber, *et al*. 2012).

In this study we found that in MET there are significantly increase muscle strength of Shoulder Joint than control group. J. Sokk, H. Gapeyeva, *et al*. 2007 stated Frozen shoulder syndrome (FSS) is typically characterized by shoulder pain, a limited range of motion (ROM) and gradual loss of strength of the shoulder muscles. 4 week individualized rehabilitation on shoulder muscle function in patients with FSS. There are significant changes in shoulder muscle strength. (J. Sokk, H. Gapeyeva, *et al*. 2007).

In this study we found that in Muscle Energy Technique (MET), there are decrease of error of Shoulder Joint proprioception. Amanda L. Ager, *et al*. 2017 stated that shoulder Joint proprioception is essential for the optimization of shoulder neuromuscular control throughout the movement, yet continues to be a quantitative challenge today. Due to the lack of standardization of proprioception terminology and complexity of evaluation methods, it remains an area of psychometric contention. The purpose of this systematic review was to identify and summarize the current methods used for quantifying shoulder proprioception, specifically JPS and kinesthesia. Although shoulder proprioception impairment is very important to evaluate and treat during rehabilitation, the protocols currently being used have not been thoroughly psychometrically tested. A proprioceptive outcome that is being used in a clinic without known psychometric qualities can lead to erroneous clinical decisions and provide a false impression that an evidence based approach is being used (Amanda L. Ager, *et al*.2017).

In our study Muscle Energy Technique (MET), Stabilization Exercise and Moist Heat Therapy (MHT) showed greater improvement pain, range of motion, muscle strength decrease error of shoulder joint proprioception. When we compared with Mean ± SD it was found that 0 week showed insignificant, 4 weeks showed significant and 8 weeks showed highly significant in diabetic frozen shoulder patients.

CONCLUSION

Our study concluded that Muscle Energy Technique (MET), Stabilization Exercise and Moist Heat Therapy (MHT) in Patients with Diabetic Frozen Shoulder showed significant improvement in pain, Range of motion, muscle strength and joint sense in 4th weeks & 8th weeks of treatment programme p values (<0.05).

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Review Article

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Recent Advances in Management of Lymphedema

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ABSTRACT

Lymphedema is a chronic condition characterized by swelling, typically in the arms or legs, caused by a compromised lymphatic system. It commonly occurs after lymph node removal or damage due to cancer treatment, trauma, or genetic disorders. The impaired lymphatic drainage leads to the accumulation of fluid, causing discomfort, decreased mobility, and an increased risk of infection. Although lymphedema is incurable, it can be managed through various approaches, including compression therapy, manual lymphatic drainage, exercise, and skin care. These strategies aim to reduce swelling, improve lymphatic flow, and enhance overall quality of life for individuals living with lymphedema. Early diagnosis and comprehensive treatment play a crucial role in effectively managing this condition.

Keywords: Recent; Management; Lymphedema.

INTRODUCTION

Lymphedema is a condition characterized by accumulation of protein rich fluid in the interstitial space and consequent tissue swelling. Early stages may have physical findings and symptoms of painless pitting edema, discomfort, and heaviness of the limb, especially after continued use.[1] However, as time passes without treatment, the condition progresses to fibrosis, thickening of the skin, and irreversible non pitting edema. The etiology of lymphedema is classified as either primary or secondary. Primary lymphedema occurs due to a congenital anomaly or absence of the lymphatic system in certain populations. Secondary lymphedema occurs due to an acquired impairment in lymphatic flow. Common etiologies include trauma, chronic infection, and malignancy.[3] The most common cause, in westernized countries, is treatment of malignancy, particularly breast cancer.

First line intervention of lymphedema includes conservative measures, such as complete decongestive therapy (CDT). CDT is a multidisciplinary treatment approach involving exercise, daily bandaging, manual drainage therapy and skin care. The intervention occurs as a 2 phase approach, with phase 1 focusing on reduction of lymphedema volume, and phase 2

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focusing on maintenance of the reduced volume. Surgical treatment of lymphedema is suggested when conservative management fails, particularly early following the onset of the swelling. The field of lymphedema surgery is a constantly evolving field. Early techniques in management of lymphedema include ablative procedures such as the Homans or Charles procedures, which involve excision of the subcutaneous tissue beneath the affected skin and covering the defect with skin flaps or a full or split thickness grafts.[13,14] Advances in microsurgical techniques have allowed the advent of more physiologic and effective methods such as vascularized lymph node transplant (VLNT) or lymphovenous anastomosis (LVA).

PHYSIOLOGIC THERAPY

Surgical techniques of lymphedema management can broadly be divided into physiologic therapy and ablative therapy. Physiologic surgical techniques are microsurgical procedures that foster the physiologic drainage of lymphatic fluid through anastomosis of lymphatic vessels with the venous system, or the incorporation of a functional lymph node in the region of ablative treatment.

LVA

LVA was first described in the 1960s by Nielubowicz and Olszewski. Artificial connection between a patent lymphatic vessel and adjacent venules to redirect lymphatic flow, allowing the lymphatic fluid to bypass obstructed lymphatic vessels. The anastomosed vessels have diameters ranging from 0.1 to 0.8 mm, requiring super microsurgical technique. LVA is more effective in early stages of lymphedema, rather than at later stages when irreversible tissue fibrosis has occurred and lymphatic smooth muscle is dysfunctional. Results not as good for lower extremity lymphedema becase large size and constantly dependent nature of lower extremities may make them less likely to improve in symptoms in comparison to the upper extremity. In a meta-analysis Jorgensen *et al.* (2018) found that prophylactic LVA at the time lymphadenectomy reduced the risk of lymphedema by 77% compared to no prophylactic procedure ($P<0.0001$)

VLNT

VLNT is a relatively new technique in the treatment of lymphedema. It was first clinically described by Clodius *et al.* (1982), who transferred a pedicled groin flap with vascularized inguinal lymph nodes to the left lower extremity with partial success in reducing lymphedema. The technique involves transfer of a vascularized lymph node and surrounding tissue to a region where a lymph node has been removed or lymph flow is impaired. A microsurgical anastomosis is created between recipient site blood supply and the flap, thereby maintaining vascularization of the lymph node. Common donor sites for the lymph nodes include omental, inguinal, mesenteric, lateral thoracic, axillary, gastroepiploic, and submental nodes.[32,33] Common recipient sites include the axilla, elbow, wrist, groin, and ankle.

Although the exact mechanism through which VLNT works is unclear, there are 2 main theories. The first is that lymph node transfer induces lymph angiogenesis at the recipient site, leading to improved lymphatic flow and alleviation of lymphedema. Lymphoscintigraphy show formation of new lymphatic channels at the recipient site following VLNT. The second proposed mechanism is that the transferred lymph node acts as a "pump", wicking lymph fluid from the surrounding interstitial space, and projecting it into the efferent venous circulation. This is based on the observation that ICG dye injected in the tissue surrounding a transferred lymph node can be found in the afferent donor and recipient venules. Lin *et al.* (2009) reasoned that the high pressure afferent arterial flow to the lymph node flap creates a local pressure gradient that transports adjacent lymphatic fluid towards the transplanted node. An advantage that VLNT has over LVA is that it can be performed in the absence of patent lymphatic vessels at the recipient site. Although the volume reduction cannot be attributed to VLNT alone, the findings suggest that VLNT can be an effective treatment in advanced lymphedema, when performed with adjunct ablative procedures. A limitation of VLNT is the risk of donor site lymphedema. Reverse lymphatic mapping prior to surgery has been proposed as a technique to prevent donor site lymphedema following VLNT.[41] This method allows the surgeon to visualize the donor site lymph nodes intra-operatively and actively avoid lymph nodes that drain the extremities, thereby lowering the risk of iatrogenic donor site lymphedema.

Ablative therapy

In advanced stages of lymphedema, where extensive interstitial tissue fibrosis has occurred, physiologic therapies may not provide sufficient volume reduction. "Rescue" procedures such as ablative surgical procedures can be used at this stage to improve aesthetic outcome, although they do not address the root cause of lymphedema. Commonly used ablative procedures include subcutaneous excisional procedures and suction assisted lipectomy.

Excisional Procedures

One of the well known procedures today is the Charles procedure, which involves radical circumferential excision of subcutaneous tissue followed by full thickness skin grafting. Modified Charles procedure negative pressure wound therapy and delayed skin grafting, in an effort to improve graft take and wound recovery.[42] Subcutaneous excisional procedures are generally preserved only for advanced lymphedema due to its poor aesthetic outcome, risk of lymphedema recurrence, infection, wound break down, and in severe cases amputation.

All Excisional Procedures produce the following Advantages:

1. Decrease limb size
2. Reduce episodes of cellulitis, and therefore improve the quality of life of the patients. Although these surgical procedures can be immediately effective to reduce the lymphedema volume, they can carry some risks including wound complications, swelling recurrence, and the need for the patient to wear compression garments lifelong to prevent recurrence.

LIPOSUCTION

Liposuction is a minimally invasive, yet effective method of lymphedema treatment. The technique involves removal of subcutaneous adipose tissue from the lymphedematous limb using a suction assisted lipectomy cannula. The target population are patients with chronic lymphedema whose pitting edema has been replaced by fatty deposits.[43] Patient satisfaction with the technique is high, as patients are encouraged to return to their daily routine with a short recovery time.[44,45] Furthermore, it can be performed as an adjunctive procedure to physiologic treatments such as LVA or VLNT to improve outcomes. Decreased infection risk following combined therapy has been reported as well.[46,47] The primary limitation of liposuction therapy is that patients must wear compressive garments indefinitely to maintain the reduced limb volume. Cosmetic and functional benefits of liposuction outweight the burden caused by lifelong compression therapy.

Combined Surgical Therapy

Recent reports of combined surgical therapy have demonstrated that performing physiological and ablative procedures together may have benefits beyond improved volume reduction (Table 1). Performing a physiological procedure such as VLNT or LVA in addition to liposuction has been shown to reduce the need for continuous compressive therapy following liposuction. While physiological procedures are most effective in early stages of lymphedema, the addition of ablative therapy can render them effective therapeutic options for late stage lymphedema as well.

Table 1: Advantages of combined therapies

Technique	Advantages over isolated procedure
LVA/LNT + Liposuction	• Improved volume reduction • Improved aesthetic cutcome • Reduced requirement of compressive garment therapy
LNT + Subcutaneous Excision (e.g., Charles, Homan Procedures)	• Improved volume reduction • Improved utility in end-stage lymphedema • Reduced requirement of compressive garment therapy

Preventive Procedure

Immediate lymphatic reconstruction Lymphedema is a refractory disease that is challenging to treat. Immediate lymphatic reconstruction has drawn attention as a novel preventive technique.[17,18] After reverse mapping with ICG lymphography, surgeons connect lymphatic vessels of the upper and lower extremities to the surrounding vein. This can improve lymphatic fluid drainage and reduce the lymphedema rate. The advantages and disadvantages of each procedure described in table (Table 2).

Table 2: Advantages and disadvantages of various methods

Technique	Advantages	Disadvantages	Comments
Lymphovenous anastomosis	• Minimally invasive surgery with the use of ICG • Can be performed prophylactically at time of lymph node dissection	• Less effective for iover extremity lymphedema • Requires a patent lymphatic vessel for anastomosis	• Performed in early stage lymphedema
Lymph node transfer	• Procedure not limited by recipient site lymphatic patency • Variety of donor sites sites available • Simultaneous breast reconstruction possible	• Risk of donor site complications (e.g., seroma, lymphedema)	• Can be performed at all stages, but most efficacious in early stage lymphedema
Liposuction	• Removes fibrofatty tissue unresolved by physiotherapy • High patient statisfaction	• Requires continuous use of compressive gament therapy if performed alone.	• Performed in all stages of lymphedema
Subcutaneous excision (e.g., Charles, Homans)	• Remove fibrofattry tissue unresolved by physiotherapy • Effective for severe lower extremity lymphedema (e.g, elephantiasis)	• Risk of surgical site complications (e.g., infection, wound dehiscence) • Poor aesthetic outcome	• Performed at end stage lymphedema

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The second page should carry the full title of the manuscript and an abstract (of no more than 150 words for case reports, brief reports and 250 words for original articles). The abstract should be structured and state the Context (Background), Aims, Settings and Design, Methods and Materials, Statistical analysis used, Results and Conclusions. Below the abstract should provide 3 to 10 keywords.

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State the background of the study and purpose of the study and summarize the rationale for the study or observation.

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Include summary of key findings (primary outcome measures, secondary outcome measures, results as they relate to a prior hypothesis); Strengths and limitations of the study (study question, study design, data collection, analysis and interpretation); Interpretation and implications in the context of the totality of evidence (is there a systematic review to refer to, if not, could one be reasonably done here and now?, What this study adds to the available evidence, effects on patient care and health policy, possible mechanisms)? Controversies raised by this study; and Future research directions (for this particular research collaboration, underlying mechanisms, clinical research). Do not repeat in detail data or other material given in the Introduction or the Results section.

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Standard journal article

[1] Flink H, Tegelberg Å, Thörn M, Lagerlöf F. Effect of oral iron supplementation on unstimulated salivary flow rate: A randomized, double-blind, placebo-controlled trial. J Oral Pathol Med 2006; 35: 540–7.

[2] Twetman S, Axelsson S, Dahlgren H, Holm AK, Källestål C, Lagerlöf F, et al. Caries-preventive effect of fluoride toothpaste: A systematic review. Acta Odontol Scand 2003; 61: 347–55.

Article in supplement or special issue

[3] Fleischer W, Reimer K. Povidone-iodine antisepsis. State of the art. Dermatology 1997; 195 Suppl 2: 3–9.

Corporate (collective) author

[4] American Academy of Periodontology. Sonic and ultrasonic scalers in periodontics. J Periodontol 2000; 71: 1792–801.

Unpublished article

[5] Garoushi S, Lassila LV, Tezvergil A, Vallittu PK. Static and fatigue compression test for particulate filler composite resin with fiber-reinforced composite substructure. Dent Mater 2006.

Personal author(s)

[6] Hosmer D, Lemeshow S. Applied logistic regression, 2nd edn. New York: Wiley-Interscience; 2000.

Chapter in book

[7] Nauntofte B, Tenovuo J, Lagerlöf F. Secretion and composition of saliva. In: Fejerskov O,

Kidd EAM, editors. Dental caries: The disease and its clinical management. Oxford: Blackwell Munksgaard; 2003. pp 7–27.

No author given

[8] World Health Organization. Oral health surveys - basic methods, 4th edn. Geneva: World Health Organization; 1997.

Reference from electronic media

[9] National Statistics Online—Trends in suicide by method in England and Wales, 1979–2001. www.statistics.gov.uk/downloads/theme_health/HSQ 20.pdf (accessed Jan 24, 2005): 7–18. Only verified references against the original documents should be cited. Authors are responsible for the accuracy and completeness of their references and for correct text citation. The number of reference should be kept limited to 20 in case of major communications and 10 for short communications.

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