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Effectiveness of pressure biofeedback training v/s isometric exercise with swiss ball on muscular endurance, ROM, functional disability in upper crossed syndrome

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Abstract

Background: Muscle imbalance is functional pathology in which strength along with length of muscle is altered. This is observed by Janda which creates abnormal joint function. Shoulder girdle crossed syndrome which has corelation with FHP and rounded shoulders. Chronic postural stress is cause of this in various occupations especially in desktop workers. In these workers muscle weakness and dysfunctional tone in musculature is seen which leads to neck pain. Pressure Biofeedback training and Swiss ball is beneficial on the local stabilizers which works at low loading maximal contractions. Stabilization of cervical spine by training the deep neck cervical flexors and neck extensors one can reduce the risk of further complications. We are focusing on deep neck flexor endurance test and isometric exercises in upper crossed syndrome.

Methodology: In this study 50 subjects both males and females with the mean age of 32.64±5.54 in Group A [pressure biofeedback training]and 32.44±5.24 Group B [isometric exercise with Swiss ball] with upper crossed syndrome were selected according to Janda's criteria using randomisation and were allocated into two groups (15 subjects in each group) using chit method. In Group A, pressure biofeedback training along with conventional exercises were given and in Group B isometric exercise with swiss ball along with conventional exercises were given. The intervention were given 3 days/week for 4 weeks. Treatment duration 20-30 min for each group. Muscular endurance (hold time), cervical ROM and functional disability were documented of each subject before and after the intervention.

Results: Muscular endurance (Hold time in seconds), Cervical ROM and NDI scores were improved significantly ($p<0.0001$) after 4 weeks in both groups. Comparison of mean differences of muscular endurance($p=0.001$), cervical flexion($p=0.0016$), extension ($p=0.005$), right side flexion($p=0.023$), left side flexion($p=0.005$), right side rotation($p=0.193$), left side rotation ($p=0.090$), NDI score($p=0.0001$) in between the groups after 4 weeks. The muscular endurance, Cervical ROM (except rotations) and NDI score improved significantly in pressure biofeedback training and isometric exercises with swiss ball group.

Conclusion: The study concluded that pressure biofeedback training was more effective than isometric exercise with swiss ball in improving muscular endurance (hold time), cervical ROM (flexion, extension, side flexions) and reducing functional disability. Whereas both are equally effective in improving cervical rotations in both the groups in upper crossed syndrome after 4 weeks.

Keywords: Upper crossed syndrome, pressure biofeedback, swiss ball, deep neck flexor muscles

Introduction

Dysfunctional tone of the musculature of shoulder girdle/cervicothoracic region is called upper crossed syndrome. It is also called as shoulder girdle crossed syndrome. [1]

Janda stated that muscle imbalance is functional pathology in which strength of opposing muscle group as well as length is altered which creates abnormal joint function. Functional pathology of motor system can improved with exercise. The serratus anterior weakness can leads to shifting of glenoid fossa and it leads to instability. Levator scapulae along with upper trapezius will maintain glenohumeral joint in centre and prevent instability. This imbalance causes atlanto occipital joint, C4-C5 segment, cervicothoracic, glenohumeral, T4-T5 segment joint dysfunction. [2]

In cervical flexors, sternocleidomastoid and anterior scelene activation increases and deep cervical flexors is reduced whereas activation of superior neck extensors increases and activity in semispinalis cervicis and multifidus is delayed. [3]

The primary cause for UCS is chronic postural stress to the upper body. Various occupations require static postures for long period of time, in which continuous contractions of head and neck muscles occurs. During work most of the tasks leads to upper cervical -spine flexion, protraction of the shoulder and internal rotation of the arms at GH joint, such as working on desktop, using smartphones. Maintaining this posture for long period increases postural stress and leads to muscle weakness or hypertonocity. [4]

Studies say that FHP is associated with rounded shoulders and increased thoracic kyphosis, to compensate this the postural deviation slouched posture occurs. In the age group of 20-50 years with healthy individuals high incidence of postural abnormalities was observed such as forward head =66%, kyphosis=38%, right and left rounded shoulders=73 and 66%. [5]

Dysfunction in local stabilizers result disturbance in function, recruitment and segmental control. Due to this postural dysfunction person feels restriction in extending upper thoracic spine, retraction of head as well as scapulae and lateral rotation of arm. If upper and deeper cervical flexors will work at low loading maximal contraction there will be reduction in stresses. There is clinical evidence that upper and deep cervical muscles will improve the endurance by reducing postural stress and providing segmental stability to joints. [6]

Deep neck flexors endurance is the average hold time for deep neck flexors. It is noted that using special test of deep neck flexor endurance the average hold time of deep cervical neck flexors is reduced in patients with cervical pain.

Biofeedback training is an instrument-based learning process. It is used to assist patients to achieve their goals. Stabilizer pressure biofeedback is used for stabilization exercises. It consist of air filled inelastic inflated bag between the neck and the surface. The pressure dial is used to monitor the pressure in the bag, as the neck lifted off the bag decreases the pressure while movement into the bag increases pressure.

Pressure biofeedback plays an important role in motor learning of the affected muscles by visual feedback and helps in increasing the strength of the muscles and improves stabilization. [7]

Studies says that Pressure biofeedback training for DNF is effective along with stretching of muscle reduces muscular imbalance and improve range of cervical joint.

Proprioception plays key role in stabilization. It provides information regarding body mechanism to higher centers during activities. Pressure biofeedback as well as swiss ball plays major role by giving proprioceptive feedback.

Swiss ball is an effective tool for healthy as well as disabled individuals that offers unlimited training possibilities. The swiss ball is a challenging training device that provides a new dimension: instability. [8]

This unique characteristic strengthens and stretches every muscle of the body in an effective way. When exercising with an exercise ball, we need to align and maintain body posture and good technique by contracting deep core stabilizing muscles.

Isometric exercise helps to hold the body position without any muscular and joint movement. Deep neck cervical exercises also help to stabilize the cervical spine, any changes in spine reduces strength and endurance of these muscles. There is necessity of improving endurance of cervical extensors along with cervical flexors. Thats why isometric exercise with swiss ball for cervical extensors are given.

Material and methods

A comparative study was done on 50 patients which are diagnosed with upper crossed syndrome according to criteria stated by Janda. [2] Both males and females between age group of 20-40 years were selected. Participants working in poor posture more than 6hrs/day since a year, having muscular endurance (<38.9 for men, < 29.4 for women), cervical ranges (flexion<40, extension<50, lateral flexion <45, rotations<70), NDI score (5-24/50), normal BMI and those willing to participate in the study were included. History of cervical trauma/surgery, surgeries of fracture to shoulder joint, cervical instability, chronic pain and headache, thoracic outlet syndrome, failing the postural screening, those who exercise regularly were excluded from the study.

Permission was taken from Institutional Ethical Committee of department of Physiotherapy. Aim and methodology of the study were explained to them and consent was taken. Participants were recruited from OPD and Hospitals around the city. Demographic data of the participants were documented. Participants were divided into two groups by random allocation 1:1 using chit method.

Group A (Pressure biofeedback training), Group B (Isometric exercises with swiss ball) And both groups received common conventional treatment protocol for 3days/week for 4 weeks.

Pre treatment muscular endurance using Deep neck flexor endurance (Hold time), All the cervical ranges using universal goniometer and NDI score were taken. [9]

Participants of the Group A had undergone pressure biofeedback training program for (5-10 min-10 reps with 2 sets). In which patient will be in supine lying with head and neck in neutral position, towel roll can be used to achieve neutral position. Patients jaw should be relaxed and tongue touched to the palate. Pressure sensor was inflated to 20mmHg which was kept behind the neck and dial was attached to pressure sensor. Deep neck flexor activation was initiated by nodding. This position was held for 10 seconds. If the patient will able to hold for 10 seconds then pressure is increased by 2mmHg. Incrementation were till 30mmHg.Muscle endurance(holding capacity) of deep neck flexors was measured by number of 10 second holds at final pressure. [10]

Group B had undergone isometric exercise with swiss ball 0.45cm of swiss ball was selected. Patients were told to stand facing away from wall maintaining erect posture and with feet should be 12 inches from the wall. Patient was instructed to tuck his chin and press the ball with occiput which is kept against the ball. Amount of resistance can be increased simply leaning over the ball with greater force. The position was held for 10 seconds with 5 seconds of gap between two reps and total 15 reps.(11)

Common conventional treatment protocol was given which included stretching to upper trapezius, levator scapulae, sternocleidomastid, suboccipitals and pectoralis minor muscles on both the sides which hold for 15-30 seconds with 3 reps. [12]

Post treatment muscular endurance using Deep neck flexor endurance (Hold time), All the cervical ranges using universal goniometer and NDI score were assessed and data were collected and statistical analysis was done.

Statistics

Graphpad Instat version 3.06 statistical software were used. The analyzed data showed it was not normally distributed using Shapiro- Wilk test. Hence non parametric test such as Wilcoxon signed rank test (paired t test) were used to analyze data within the groups and Mann-Whitney rank-sum test (unpaired t test) were used to analyze data between the groups.

Ethical approval

After seeking permission from the Institutional Research Review Committee of Department of Physiotherapy, P.E.S. Modern College of Physiotherapy, Pune, ethical clearance was obtained.

Results

Table 1: Demographic data which includes gender wise distribution, mean age and mean BMI.

Demographic data	Group A	Group B
Gender	13	13
Men	13	13
Women	12	12
Age (Mean SD)	32.64±5.54	32.44±5.24
BMI (Mean SD)	22.06 ±1.688	22.79±1.592

Table 2: Comparisons of the differences in muscular endurance, cervical ROM and NDI within each group:

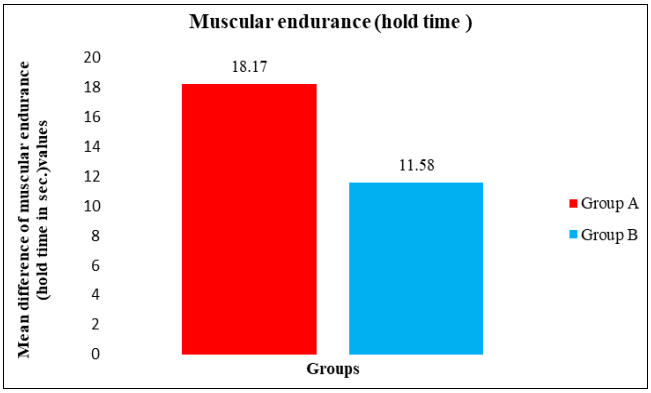
		Pre	Post	P
Muscular endurance	Group A Group B	17.56 ±4.36 17.05± 6.81	35.74 ±5.68 28.64 ±6.25	0.0001
Cervical Flexion	Group A Group B	35.72± 2.24 34.96 ±2.30	46.28 ±2.22 43.72 ±2.79	0.0001
Extension	Group A Group B	41.76 ±2.86 43.68 ±2.39	49.88 ±1.78 49 ±1.89	0.0001
Right side Flexion	Group A Group B	35.36 ±3.38 35.52 ±1.44	46.28 ±3.38 44.4 ±2.16	0.0001
Left side Flexion	Group A Group B	35.48 ±1.38 37.96± 2.96	46.6 ±2.81 48.6 ±2.021	0.0001
Right side Rotation	Group A Group B	57± 2.73 59.24± 2.53	67.68± 3.73 69.16± 2.57	0.0001
Left side rotation	Group A Group B	58.2 ±3.09 57.84± 2.62	68.88 ±2.92 67.08 ±3.82	0.0001
NDI score	Group A Group B	14 ±5.08 15.44 ±3.80	6.16 ±2.87 9.76± 2.47	0.0001

Interpretation

Pre and post muscular endurance (hold time), All the cervical ROM and NDI score in both the groups having p value <0.0001 which is highly significant, improving muscle endurance, cervical ranges and NDI score.

Table 3: Comparison of mean differences of Muscular endurance, cervical ROM and NDI between the groups:

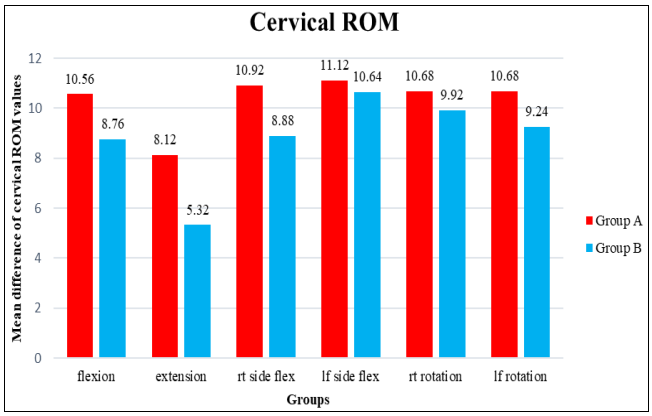
	Group A	Group B	P
Muscular endurance	18.17 ±3.97	11.58 ±3.95	0.0001
Cervical Flexion	10.56 ±3.16	8.76± 2.919	0.0016
Extension	8.120 ±2.69	5.32 ±1.57	0.005
Right side Flexion	10.92 ±3.10	8.88 ±2.55	0.023
Left side Flexion	10.64± 2.34	11.12± 3.33	0.005
Right side Rotation	10.68± 3.38	9.92 ±1.89	0.193
Left side rotation	10.68± 0.17	9.24 ±3.21	0.090
NDI score	7.84 ±3.36	5.68 ±2.13	0.0001



Graph 1: Comparison of Mean differences of muscular endurance (hold time) in between the groups

Interpretation

Mean difference of muscular endurance (hold time) in group A is 18.17seconds and in group B is 11.58 seconds. which is highly significant p<0.0001. Thus the treatment of Group A (pressure biofeedback training) is more effective than Group B (Isometric exercise with swiss ball) on improving muscular endurance in upper crossed syndrome after 4 weeks.

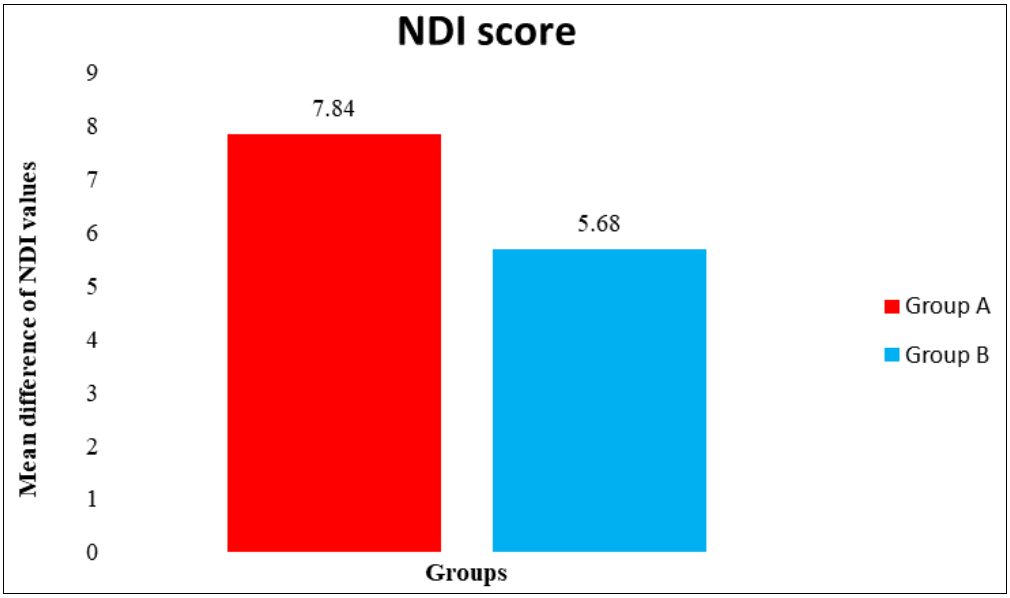


Graph 2: Comparison of Mean differences of cervical ROM in between the groups

Interpretation

Mean difference for cervical flexion, extension, right side and left side flexion is very significant when compared in group A and group B. Thus the treatment of Group A (pressure biofeedback training) is more effective than Group B (Isometric exercise with swiss ball) on improving these ranges in upper crossed syndrome after 4 weeks.

Mean difference for right side and left side rotations is not significant when compared in Group A and group B. Thus group A (pressure biofeedback training) and Group B (isometric exercise with swiss ball) are equally effective on cervical rotations in upper crossed syndrome after 4 weeks.



Graph 3: Comparison of Mean differences of NDI score in between the groups:

Interpretation

Mean difference of muscular endurance (hold time) in group A is 7.84 and in group B is 5.68, which is highly significant $p<0.0001$. Thus the treatment of Group A (pressure biofeedback training) is more effective than Group B (Isometric exercise with swiss ball) on improving functional disability in upper crossed syndrome after 4 weeks.

Discussion

Upper crossed syndrome is seen maximally in people with slouched posture for long period of time. This is due to changes in phasic and tonic muscles. Due to static postures these muscles get tighten and weaken, leads to neck pain and changes in cervical spine. Along with that protraction of cervical spine occurs.

Wontae Gong *et al* stated that there is correlation between the cervical lordosis, Range of motion, pain and muscular endurance. So stability to the joint will improve pain, muscular endurance and range of motion. [5]

One Egyptian study proved that in overweight and obese people craniovertebral angle changes leading to forward head posture also shoulder angle is changed and so rounded shoulder appeared. COG shifts anteriorly and affects torque due to weight of head in obese. Obesity is associated with forward head posture that's why our study included patients with normal BMI. [13]

Deep cervical flexor training with a pressure biofeedback unit is a useful method for maintaining neck mobility and muscular endurance in forward head posture. Dong Yeon Kang had given stretching for 10min before the training and conventional deep cervical flexor exercises. He found significant improvement in cervical ROM, muscular endurance and NDI score. [14]

Rectus capitus anterior and lateralis, longus capitus, longus colli muscles are assessed by using special test of deep cervical neck flexors in which substitution of platysma and sternocleidomastoid occurs. Less studies have been done using this test.. The current study focuses on the average hold time of neck flexor endurance which previously done in normal individuals, and we included in patients with upper crossed syndrome. [7]

Michael Duncan *et al* has been stated that muscle activity was greater when exercises were performed on swiss ball than stable surface. [15] Swiss ball has effect on neck pain and cervical range of motion in forward head posture. In this study there was reduction in pain and increase in cervical flexion range after 4weeks. Strengthening to neck flexors and scapular retractors for stabilization exercises were given in the study. These exercises on swiss ball were more effective than mat exercises.

Stretching to upper trapezius along with levator scapula muscle increases cervical flexion and rotations immediately after the stretch in UCS. Wong Sik Bae *et al*. said that strengthening of middle as well as lower trapezius and stretching of levator and upper trapezius is effective. [16] Lee *et al* suggested these selective exercises which reduces pain and improves muscular endurance. Our study included similar stretching exercises which are effective in UCS. Stretching improves blood circulation to the area and improves flexibility by changing the length-tension relationship of muscle thus improves range of motion of the joint.

Comparison of isometric cervical extensors with isometric cervical flexors system on upper crossed syndrome was done by Lee jaejin *et al*. They concluded that the thickness of SCM was maximum during isometric contraction of flexors and longus coli during contraction of extensors. Upper trapezius and pectoralis muscle with lower trapezius muscle imbalance ratio was reduced during isometric contraction to cervical extensors than flexors. [17] In Current study we focused on isometric exercises with swiss ball on cervical extensors which also improving deep cervical muscular endurance (hold time).

Core stabilization means contraction of deep muscles of the cervical joint which helps to give stability to the joint. Isometric exercises helps in improving muscle tension and strength without any movement and relieve pain by strengthening deep cervical muscles.[17]

Our study mainly focused on the comparison of effect of pressure biofeedback training and isometric exercises with swiss ball.

Pressure biofeedback training improves craniocervical joint stability by improving muscular endurance of deep neck flexors. Along with improvement in muscular endurance flexibility of tight muscles also increases. It reduces the postural dysfunctional pattern in upper crossed syndrome. Hence it could be more effective in improving muscular endurance (hold time), Range of motion and NDI score than isometric exercise with swiss ball.

Conclusion

Pressure biofeedback training is more effective than isometric exercises with swiss ball on improving muscular endurance (hold time), cervical range of motion and NDI score, But both the techniques are equally effective in improving cervical rotations along with conventional treatment in patients with upper crossed syndrome after 4 weeks.

Limitations

Homogeneity was not maintained.

No follow up taken after 4 weeks to check up long term effects of intervention techniques.

Future scope of study

1. The study can be carried out in different occupational groups.
2. Study can be carried out and compared in between genders.
3. We haven't focused on the posture, further studies can be taken using posture as an outcome measure.
4. Isometric exercises with swiss ball can be given for longer period more than 4 weeks to see the effect.

Acknowledgment

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