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Effects of Subcranial Myofascial Distraction and Condylar Remodeling Exercises in Patients with Temporomandibular Joint Disorders

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Abstract: ***Aim: Studying effect of subcranial myofascial distraction and condylar remodeling exercises in temporomandibular joint disorders. Methods: A randomized control trial carried out amongst 120 temporomandibular disorder patients, divided into 3 groups of 40 each, GroupA-subcranial myofascial distraction, GroupB- combination of subcranial myofascial distraction and condylar remodeling exercises, GroupC- condylar remodeling exercises alone. Patients were assessed for temporomandibular range of motion, temporomandibular disability index score and patient specific functional scale score. Frequency for subcranial myofascial distraction was 3 repetitions of 90 seconds hold period each, rest period of 60 seconds between two repetitions. Intervention was given for 6 days/week for 2 weeks. Each condylar remodeling exercise was performed 6 times/session and same performed at home for 6 days/week for 2 weeks. Results: Data analyzed using one way ANOVA, repeated measure ANOVA, Post hoc bonferroni test, Kruskal Wallis Non-parametric ANOVA. Combination of subcranial myofascial distraction and condylar remodeling exercises (group B)showed greater improvement compared to group C and A. Conclusion: subcranial myofascial distraction and condylar remodeling exercises help in decreasing disability associated with temporomandibular joint disorder.***

Keywords: temporomandibular disorder, subcranial myofascial distraction, condylar remodeling exercises, temporomandibular joint range of motion, temporomandibular disability index score, patient specific functional score.

1. Introduction

The stomatognathic system is an integral part of the musculoskeletal system.[1]This complete kinetic chain is also referred as cranio -cervico-mandibular system. stomatognathic system is characterised by several structures which act in harmony to perform different functional tasks such as communication, mastication, swallowing, stabilization and proprioception.[2]

The Temporomandibular joint, a component of stomatognathic system, is one of the most frequently used joints in the body [3] and is responsible for all movements of the jaw, which take place in different orthogonal planes and around multiple axes of rotation.[2] On average, temporomandibular joint is used around 1500–2000 times a day.[1]Dysfunctions of temporomandibular joint can directly influence joints and muscles of stomatognathic system which increases physical and emotional stress on this system by influencing performance of functional activities.[4]

Musculoskeletal structural disorders of the masticatory system are frequent: 50% to 75% of the population presents at least one sign of temporomandibular disorder (TMD) and among these, 25% present symptoms of this disorder (Iunes Carvalho 2009)[5]. According to Karolina Dragon (2011), 8 out of 10 patients coming to the dentist are found to have temporomandibular disorders.[1]

In a study by Solberg (2014), 76% of subjects aged 18–25 years had one or more signs associated with temporomandibular disorders and 26% had at least one symptom associated with temporomandibular disorders [6]. Although temporomandibular joint (TMJ) problems can occur in individuals of any age, they are most common in individuals 18 to 30 years of age

Activities [1] nowadays, the assessment of the existence of a significant relationship between neck pain and temporomandibular disorders could be of important practical relevance. This kinetic link is still far from being clarified. Its relevance has been pointed out by different authors (Riccardo Ciancaglini 1999, Friedman M.H 1996) and also by the American Academy of Orofacial Pain, which in its guidelines considers evaluation of evaluation of the range of motion and palpation of cervical muscles to be an important part of the diagnostic protocol for identification of craniomandibular disorders.[6]

Patients who present with dysfunctions of cranio-cervico-mandibular chain can be treated effectively by a physical therapist who has specialized skills and experiences. For effective, long lasting management of patients with temporomandibular disorders, inclusion of a physiotherapist in a team is essential but role of physiotherapist is not evident among dentists .[8] Patients who present with dysfunctions of cranio-cervico-mandibular chain can be treated effectively by a physical therapists who are able to use a more standardized classification and better diagnostic and therapeutic methods to offer patients a wide range of treatment modalities with higher success rates[15],[8]

Physical therapy management of temporomandibular disorder, a multifactorial syndrome ,often consists of physical modalities, postural re-education, soft tissue mobilisation , therapeutic exercise for neuromuscular stabilisation of the temporomandibular joint, manual therapy including temporomandibular joint mobilisation.[9]

Moreover, manual therapy is the most commonly used approach in management of spinal conditions and useful method for temporomandibular disorder management as stated byAysener Tuncer (2011)

Myofascial release technique known as Subcranial Myofascial distraction is frequently used in cervical spine disorders to achieve the most efficient movement patterns that the patient's body can maintain with the least amount of effort while minimizing or eliminating the patient's pain complaint.[10]

Furto et al (2006) used a temporomandibular joint exercise program developed by Rocabado called "Condylar remodeling exercises". These are the effective self regulatory and neuromuscular relaxation training exercise which is thought to increase functional mobility and motor control around temporomandibular joint.[9]

However, there are no well-designed studies that demonstrate that treatment provided by physical therapist to cervical spine has an influence on temporomandibular dysfunction and the resulting complaints[11] , this study is the step with a aim of assessing effects of subcranial myofascial distraction and condylar remodeling exercises in patients with temporomandibular joint disorders.

2. Objective

To evaluate effects of subcranial myofascial distraction and condylar remodeling exercises on temporomandibular joint mobility, temporomandibular disability index and patient specific functional scale in patients with temporomandibular joint disorder.

3. Methods

A randomized control trail was carried out amongst 120 patients with temporomandibular joint disorder. Individuals of both genders in the age group of 18-30 years who were diagnosed as temporomandibular disorder were included in the study. Post surgical, degenerative and traumatic conditions related to temporomandibular joint and cervical spine were excluded.

Outcome measures were temporomandibular joint range of motion with the help of vernier calliper, temporomandibular disability index score and patient specific functional scale score.

Number of patients were divided into:
Group A(n=40) subcranial myofascial distraction
Group B (n=40) combination of subcranial myofascial distraction and condylar remodeling exercises
Group C (n=40) condylar remodeling exercises

Subcranial myofascial distraction and/or condylar remodeling exercises were given to all 3 groups for 6 days per week for 2weeks. Post intervention assessment was done at the end of 1st and 2nd week.

Subcranial myofascial distraction (group A and group C): 3 repetitions of subcranial myofascial distraction, with hold period of 90 seconds each and rest period of 60 seconds between 2 repetitions were given for 6 days / week for 2 weeks.

Condylar remodeling exercises (group B and group C) included range of motion phase, bite phase, bite return phase, protrusion, isometric contraction phase and tubing distraction. Each exercise was performed 6 times in one session under the supervision of physiotherapist and same session was performed daily at home by patient for 6 days/ week for 2 weeks.

End position.

Range of motion phase.

Bite phase.

Bite return phase.

Protrusion.

Isometric contraction

Tubing distraction

4. Results and Data Analysis

Data analysis was done by using One way ANOVA; To compare mean age between group A, group B, group C. Repeated measure ANOVA was used to compare temporomandibular joint range of motion, temporomandibular disability index score and patient specific functional scale score among group A, group B and group C prior intervention (subcranial myofascial distraction and condylar remodeling exercises) and post intervention at the end of 1st and 2nd week.

One Way Non-parametric ANOVA: To compare the changes in temporomandibular joint range of motion, temporomandibular disability index score and patient specific functional scale score among group A, group B and group C after giving intervention (subcranial myofascial distraction and condylar remodeling exercises) at 1st and 2 nd week from prior test.

Post hoc bonferroni test: To perform multiple comparison of To compare temporomandibular joint range of motion. Kruskal Wallis Non parametric ANOVA test: To measure temporomandibular disability index score among group A, group B and group C after giving intervention (subcranial myofascial distraction and condylar remodeling exercises) at 1st and 2nd week.

Table 1: Pre intervention and post intervention range of motion at TMJ in (mm) in group A, group B and group C.

Mandibular depression	*group A*	*group B*	*group C*
pre intervension	22.82± 4.55	21.78± 4.81	22.80± 4.62
post intervention 1st wk	28.69± 3.16	31.32 ±5.21	30.64± 2.17
2nd wk	33.64± 5.35	39.86± 2.62	35.89± 1.30
F-value	91.49	813.67	270.78
P-value	<0.0001,HS	<0.0001,HS	<0.0001,HS
Mandibular protrusion	group A	group B	group C
pre intervension	1.93± 0.29	2.01± 0.38	1.94± 0.31
post intervention 1st wk	2.51± 0.13	2.80± 0.31	2.20± 0.30
2nd wk	2.58± 0.24	3.95± 0.39	2.61± 0.37
F-value	239.55	654.96	141.53
P-value	<0.0001,HS	<0.0001,HS	<0.0001,HS
Mandibular lateral deviation (Rt.)	group A	group B	group C
pre intervension	5.18 ±0.35	5.14 ±0.40	5.07 ±0.82
post intervention 1st wk	7.79 ±0.67	7.89± 0.85	6.8± 0.53
2nd wk	9.80± 0.84	11.07 ±1.38	9.39 ±1.27
F-value	741.65	508.47	314.01
P-value	<0.0001,HS	<0.0001,HS	<0.0001,HS
Mandibular lateral deviation (Lt.)	group A	group B	group C
pre intervension	5.3 ±0.34	5.33± 0.44	6.17± 0.53
post intervention 1st wk	7.0 ±0.68	7.83± 0.85	6.90± 0.44
2nd wk	9.74± 0.80	11.24± 1.38	11.32 ±1.30
F-value	790.62	504.92	538.96
P-value	<0.0001,HS	<0.0001,HS	<0.0001,HS

With two weeks of intervention, statistically highly significant increase in all movements of TMJ in group A, group B and group C was noted which reveals that both subcranial myofascial distraction and condylar remodeling exercises are effective in combination as well as individually.

Table 2: Comparison of mean change in TMJ movements (mm) with intervention between three groups

Mandibular depression (mm)					
time (week)	Group A	Group B	Group C	F-value	P-value
1st week	5.85± 2.69 (-15.18)	9.56± 1.57 (-55.7)	7.78 ±3.53 (27.6)	18.6	0.0001,HS
2nd week	10.81± 6.32 (46.2)	18.03± 3.28 (132.2)	13.03± 4.74 (66.7)	22.37	0.0001,HS
Mandibular protrusion (mm)					
time (week)	Group A	Group B	Group C	F-value	P-value
1st week	0.57± 0.22 (30.05)	0.78± 0.23 (39.30)	0.26± 0.20 (13.40)	63.8	0.0001,HS
2nd week	0.64± 0.20 (33.67)	1.93± 0.45 (96.51)	0.67 ±0.32 (34.53)	193.66	0.0001,HS
Rigth Mandibular lateral devistion (mm)					
time (week)	Group A	Group B	Group C	F-value	P-value
1st week	2.60±0.59 (50.38)	2.79 ± 0.96 (53.50)	1.63 ± 0.59 (34.12)	27.89	0.0001,HS
2nd week	4.62 ± 0.99 (89.18)	5.99 ±1.44 (115.37)	4.43 ± 0.04 (85.20)	22.06	0.0001,HS
Left Mandibular lateral devistion (mm)					
time (week)	Group A	Group B	Group C	F-value	P-value
1st week	1.99 ±0.59 (32.07)	2.56± 1.03 (47.16)	1.73 ±0.52 (11.83)	12.65	0.0001,HS
2nd week	4.71± 0.92 (83.01)	4.46± 0.90 (112.07)	4.46± 0.90 (83.46)	20.92	0.0001,HS

Statistically highly significant improvement in TMJ range of motion was found with intervention at the end of 1st and 2nd week when compared to pre intervention.

Table 3: Comparison of post intervention mean changes in TMJ movements (mm) at end of 1st and 2nd week between three groups

mandibular depression	*1st week*	*2nd week*
groupA vs groupB	3.71(<0.0001)*	7.21(<0.0001)
groupA vs groupC	1.93(<0.0001)	2.22(<0.0001)
groupB vs groupC	-1.78(0.012)	-4.99(<0.0001)
mandibular protrusion	*1st week*	*2nd week*
groupA vs groupB	0.14(<0.013)*	1.36(<0.0001)
groupA vs groupC	-0.38(<0.001)	0.10(0.593)
groupB vs groupC	-0.52(<0.001)	-1.26(<0.001)
mandibular lateral deviation (Rt)	*1st week*	*2nd week*
groupA vs groupB	0.18(0.817)	1.37(<0.001)
groupA vs groupC	0.96(<0.001)	0.19(1.00)
groupB vs groupC	1.15(<0.001)	1.56(<0.001)
mandibular lateral deviation (Lt)	*1st week*	*2nd week*

groupA vs groupB	0.56(0.003)	1.27(<0.001)
groupA vs groupC	0.26(0.369)	0.25(0.968)
groupB vs groupC	0.83(<0.0001)	1.52(<0.0001)

TMJ movements i.e Mandibular depression, mandibular protrusion, right(Rt)and left (Lt) Lateral deviations showed more improvement in group B than group C than group A.[TABLE 3] Thus ,combination of subcranial myofascial distraction and condylar remodeling exercises is better than only subcranial myofascial distraction or condylar remodeling exercises.

Table 4: Pre intervention and post intervention TMD disability index score in group A, group B and C

Group	Group-A	Group-B	Group-C
Pre intervention	16.95± 9.32	25.42± 9.55	25.47± 9.34
Post intervention1st wk	15.37± 8.39	22.75± 8.85	23.67 ±9.09
2nd wk	13.22± 7.97	16.67± 7.60	19.15±8.80
F-value	34.93	238.48	176.41
p-value	<0.0001,HS	<0.0001,HS	<0.0001,HS

Statistically highly significant decrease in TMD disability index score in group A, group B and group C was noted as p<0.0001.

Table 5: Comparison of mean change in TMD disability index score with intervention between 3 groups

Time (week)	Group-A	Group-B	Group-C	KW statistics (Chi2value)	p-value
1st week	1.57± 2.87 (9.3)	2.67 ±1.43 (10.5)	1.8± 1.47 (7.06)	10.64	0.0049,HS
2nd week	3.72±3.55 (22.2)	8.75± 3.26 (34.4)	6.32± 2.71 (24.8)	35.47	0.0001,HS

HS: highly significant

Comparison of mean change in TMD disability index score revealed statistically highly significant decrease in TMD disability score with intervention at the end of 1st and 2nd week

Table 6: Comparison of mean changes post intervention in TMD disability score at end of 1st and 2nd week between 3 groups

Comparison	At 1st week	2nd week
GroupA **vs** Group-B	1.1(0.0059)*	5.02(<0.0001)
GroupA **vs** Group-C	0.22(0.075)	2.6(0.0007)
Group-B **vs** Group-C	0.875(0.00354)	2.42(0.0009)

Group wise comparison of change in TMD disability index score with intervention revealed statistically significant change in group A and group B (p =0.0059 and <0.0001);

Comparison between group A and Group C showed statistically non significant change at end of 1stweek (p=0.075), highly significant change at end of 2nd week and (p=0.007) ; And highly significant result was obtained when group B and group C was compared (p =0.00354 & 0.0009); Thus, TMD disability index score was decreased more in group B than group C than group A.

Table 7: Pre & post intervention Patient specific functional score (PSFS) in group A, group B, group C.

Group	Group-A	Group-B	Group-C
Pre intervention	7.27± 2.03	8.47± 2.19	7.05± 1.53
Post intervention1st wk	8.77± 1.84	11.32± 1.97	8.37 ±1.69
2nd wk	11.52± 2.28	13.35± 1.72	10.35±1.94
F-value	108.14	341.39	176.61
p-value	<0.0001,HS	<0.0001,HS	<0.0001,HS

HS: highly significant

Statistically highly significant increase in PSFS score in group A, group Band group C was noted as p<0.0001.

Table 8: Comparison of mean change in Patient specific functional scale score with intervention at the end of 1st and 2nd week from pre intervention between 3 groups

Time (week)	Group-A	Group-B	Group-C	KW statistics (Chi2 value)	p-value
1st week	1.5± 1.10 (20.6)	2.85 ±1.09 (33.6)	1.32± 1.11 (18.7)	35.42	<0.0001,HS
2nd week	3.25 ±1.76 (44.7)	4.87± 1.42 (57.6)	3.3± 1.38 (46.8)	25.05	0.0001,HS

HS: highly significant

Statistically highly significant increase in PSFS score was found with intervention at the end of 1st and 2nd week when compared to pre intervention

Table 9: Comparison of mean changes post intervention in Patient specific functional scale scores at end of 1st and 2nd week between 3 groups.

Comparison	At 1st week	2nd week
GroupA **vs** Group-B	1.35(<0.0001)	1.625(0.0004)
GroupA **vs** Group-C	0.75(0.0.5261)	0.05(0.8742)
Group-B **vs** Group-C	1.53(<0.0001)	1.58(0.0002)

Group wise comparison of change in PSFS score with intervention revealed that:Statistically significant change in group A and group B (p <0.0001 and 0.0004); Comparison between group A and Group C showed statistically non significant change of (p=0.52, 0.87);And statistically highly significant result was obtained when group B and group C was compared (p <0.0001 & 0.002); Thus, PSFS score was increased more in group B than group C than group A.

5. Discussion

Post intervention week wise noticeable improvement in three outcome measurement i. e. temporomandibular joint movements temporomandibular disability index and patient specific functional scale was statistically highly significant (p=0.0001) in all three groups.Intergroup comparison revealed that improvement was more remarkable in group B which received combination of subcranial myofascial distraction and condylar remodeling exercises, than group C (condylar remodeling exercises) , than group A(subcranial myofascial distraction).

The close correlation of temporomandibular disorders with cervical spine disorders has been reported by several researches (R La Touche 2009, S.A Olivo 2010). They concluded that patients who have temporomandibular disorder report neck symptoms more frequently than patients who do not have temporomandibular disorders .At the same time, patients who have neck pain report more signs and symptoms of temporomandibular disorders than those who have no neck pain. [17]

Cristiane Pedroni (2005) reported that stomatognathic and cervical systems should be considered functionally as one. The abnormal function of muscles and joints of the cervical region can be a probable cause for the greater frequency of pain in the orofacial region due to the functional relation between temporomandibular Joint (TMJ) and the craniocervical region where movements of atlanto-occipital joint and cervical vertebrae occur concomitantly with activation of masticatory muscles and jaw movements. Therefore, myofascial imbalance in this region could lead to disruption of motor control, compromising normal mandibular function. [18]

In the current study, positive effects of subcranial myofascial distraction technique on temporomandibular disorders is explained by interconnection between cervical spine and temporomandibular joint in terms of neurophysiological, biomechanical and neuroanatomical aspects.

Neurophysiologically, there is convergence and central excitatory connection between trigeminal nerve and trigeminocervical nucleus. Biomechanically, temporomandibular system and cervical spine behave as one functional unit. Co-contraction can be observed with jaw and neck muscles during activities like chewing, talking, and yawning.[15] Masticatory muscles contract in response to the contraction of cervical spine muscles as these muscles act as agonist and antagonist to one another.

Muscle abuse caused by postural malalignment, occupational stress, micro trauma etc. causes myofascial imbalance characterised by hypertonicity of certain muscles of cervical spine especially extensors.

Manual therapy technique such as subcranial myofascial distraction when applied to cervical spine normalises cranio-cervico-mandibular chain by reversing sequence of events of muscular imbalance . Subcranial myofascial distraction have a damping influence on the gamma activity by reducing threshold within the facilitated segment i.e. cervical extensors and thus open a window of opportunity for the central nervous system to normalize level of neural activity. This results in cervical extensors relaxation [19] which are linked with masticatory muscles; consequently normalising muscle activity around temporomandibular joint and gaining a positive change in mobility at temporomandibular joint.
Another effect of subcranial myofascial distraction which results in increased range of motion is decrease in the internal pressure of articulations attained by longitudinal traction, which allows an influx of synovial fluid responsible for articular lubrication.[18] One of the most powerful effects of subcranial myofascial distraction technique is the ability to re-train patterns of motor signals in body, and establish new pathways by activating type I mechanoreceptors. Stimulation of these mechanoreceptors caused by this technique contributes to the gain in range of motion as they participate in regulating postural and muscular tonus.
According to Carmeli E et al 2001, use of combined manual therapy and exercise reduces pain and causes increased range of motion in patients with articular temporomandibular disorders. Hence, they suggested that exercises should be incorporated along with manual therapy for appropriate management of temporomandibular disorder patients.

Condylar remodelling exercises are aimed to facilitate neuromuscular stabilization through the use of repetitive lateral deviation motions purportedly used to assist with mobility. Theoretically, muscles of mastication are then recruited to apply a compressive force to the disk, thereby improving condylar-disk-eminence congruency and ultimately improving function. These techniques can also be used as a proprioceptive exercise to increase functional mobility with lowered pain response.[11]

Condylar remodeling exercises stimulates mechanoreceptors which are specialised end organ that converts mechanical energy of physical deformation into action nerve potential yielding proprioceptive information, detecting change and rate of change, as opposed to steady state conditions. This input which is analysed in the central nervous system for joint position and movement influences muscle tone, motor execution programmes and kinaesthetic awareness around temporomandibular joint protecting joint from damage and helps to restore appropriate balance of synergistic and antagonistic forces.[21]

Improvement in joint mobility directly influences disability and functional capacity associated with same joint. The percent improvement in eating which is one of the normal living activities in disability index was 12.5 % in group A, 32.5% in group B and 15% in group C respectively,percent improvement in talking in group A was 12.5%, Group B was 27.5 %, Group C was 7.5%, approximately similar results in headache symptoms were observed, where group B showed more improvement.

6. Conclusion

The current study demonstrated that subcranial myofascial distraction and condylar remodeling exercises when used in conjunction with one another over a period of 2 weeks provides both statistically significant and practically relevant improvement in temporomandibular joint range of motion, temporomandibular disability index(TDI) score and patient specific functional scale score (PSFS) .When subcranial myofascial distraction and condylar remodeling exercises were studied individually, both have shown improvement in all the three outcome measures .

7. Clinical implication

Functional jaw movements are the result of unrestricted activation of jaw as well as head and neck muscles, leading

to simultaneous movements in the temporomandibular, atlantooccipital and cervical spine joints.

Hence, in the treatment of temporomandibular joint dysfunction, the clinician should understand that it is a complex that is being dealt with and management should include treatment of other links of this kinetic chain like cervical spine which can influence the temporomandibular joint directly or indirectly.

Manual therapy techniques like subcranial myofascial distraction used to improve movement potentials, reduce restrictions, ease pain and to restore normal function to previously dysfunctional tissues can be highly efficacious for improving and maintaining myofascial harmony of complete kinetic chain i.e. stomatognathic system.

Condylar remodeling exercises improve extensibility of specific muscles around orofacial area and should be taught to the patient to augment prognosis. These exercises are easy to perform, so they can be included in the home exercise program.
Physiotherapists should be an important member of the group of health practitioners who work with patients of these disorders. Hence, awareness about the role of physical therapist in TMDs should be inculcated amongst physicians and dentists.

Thus, interdisciplinary co-operation between the dentist & physiotherapist is essential to reduce physical, social & psychological impact of chronic conditions of stomatognathic system like temporomandibular disorder.

8. Limitations

Intervention was given for a short duration i.e. two weeks and follow up was not taken thereafter.

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