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ORIGINAL RESEARCH

Comparison of Muscle Endurance and Motion of Cervical and Temporomandibular Joints in Patients with Temporomandibular Disorder and Healthy Subjects

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ABSTRACT

Introduction: Despite the high prevalence and cost of temporomandibular disorders (TMDs), there are little data available on the changes in the physical characteristics of the neck associated with different types of TMDs.

Objective: To investigate the association between TMDs and (1) the endurance time of neck muscles and neck range of motion (flexion and extension), (2) the endurance time of masticatory muscles and mouth opening range of motion.

Design: A case–control study design.

Materials and methods: Sixty Iranian volunteers with and without TMD were selected and measured for neck muscle endurance, neck flexion and extension range of motion, mouth opening range of motion, and masticatory muscle endurance.

Results: Neck muscle endurance time and neck flexion range of motion were significantly lower in patients compared with healthy subjects. There were no significant differences in masticatory muscle endurance, mouth opening, and neck extension range of motion between the groups.

Conclusion: These results highlight the fact that alteration in neck endurance muscle and neck flexion and range of motion could be implicated in patients with TMDs.

Keywords: Muscular endurance, Range of motion, Temporomandibular disorder.

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INTRODUCTION

Temporomandibular disorder (TMD) is characterized by signs and symptoms associated with pain, functional and structural disturbances of the masticatory system, the temporomandibular joints (TMJs), and surrounding structures, such as cervical muscles.[1,2] According to the International Association for the Study of Pain, TMD characteristics are pain and tenderness in masticatory muscles and TMJs and often associate with TMJ sounds and changes in range of mandibular movements.[3] Diseases of TMJ and surrounding structures involve a large number of population, with an average of more than 20% of the population experiencing symptoms of involvement.[4] The discomfort of TMD, such as back pain and headache have been reported and economical cost allocated to it.[5] Since there are several factors in the etiology of TMD, the treatment of such disorders requires a multidisciplinary approach including dentists, physiotherapists, psychologists, speech therapists, and other health professionals.[6]

Recently, some clinical evidence demonstrated interconnection between the cervical spine and TMD, so that approximately 88% of TMD patients have also reported neck pain. The results of studies using animals have revealed relationship between the craniofacial and cervical complex.[7] For example, results of Hellström et al[8] demonstrated that bradykinin injection into the TMJs changes the muscle spindle sensitivity in cervical muscles. In addition, Kobayashi et al[9] applied stimulation of TMJ capsule and found that pressure receptors in TMJ capsule control tonic activation of motor units in splenius muscle in cervical region.

Thus, it seems that disorders of the jaw joint and the muscles of mastication are likely to be the cause of disorders of the neck and vice versa. There is some evidence that indicates TMJ sensory receptors and muscle spindle in dorsal cervical spine are responsible for sensory motor alteration in cervical muscles in TMD patients, which were responsible in the mechanism of pathophysiology of this joint.[10]

Previous studies reported conflicting result about relationship between angles and muscle function of head and neck with the presence of TMD. Armijo-Olivo and Magee[5] showed that in TMD patients, cervical flexor and extensor muscle endurance is reduced. Although there have been many studies for evaluating the masticatory muscles and bite force,[11] there are no data about the changes of masticatory endurance and their relation with neck muscles as well as neck and jaw range of motion changes associated with this disorder. By defining the type of this relationship, perhaps a more complete plan of treatment may be prescribed for these patients. The aim of the present study was to examine whether any consistence pattern could be found between two parameters of muscular endurance and range of motion in the cervical and TMJ in subjects with and without TMD.

MATERIALS AND METHODS

This study was a case–control study in which 60 subjects were evaluated blindly. The patients who attended were from the TMD Orofacial Pain Clinic in the School of Dentistry of Tehran University of Medical Sciences. Written and verbal consent was obtained from each participant and before they had been informed about the procedures. The research was approved by the Ethics Committee of faculty rehabilitation of Tehran University of Medical Science. The criteria for inclusion in healthy group were based on men 20 to 40 years of age with no symptoms in the neck and TMJ for the last 6 months. Also the patients with TMD were included if they were men between 20 and 40 years of age and had pain in the masticatory muscles/TMJ. Patients were having myofascial pain and myofascial pain with or without limited opening classification based on Research Diagnostic Criteria/TMD. Exclusion criteria were TMJ pain due to the recent acute trauma, active inflammatory disease, and previous infection or sever deformity in jaw or face. Participants were asked to read and sign a consent form. The study was approved by Ethical Committee of Tehran University of Medical Sciences. Demographic data, such as age, weight, and height were collected from all participants.

Procedure of Patient Positioning

Before the experiment began, patients were asked to perform a warm-up exercise which consisted of four movements of the neck and head in all directions (including extension/flexion, lateral flexion, and rotation) and mouth opening.

Then each participant sat on a chair with a comfortable back support.

For measuring head and neck range of motion fixed arm of goniometer was established parallel to the horizontal line and its movable arm moved along a card fixed between the teeth of our participants in clenching position (bite plane).

For flexion movement, participants were asked to look down to receive chin to manubrium of sternum. While the therapist index finger was monitoring T1 spinous process to prevent participation of the thoracic spine, also for extension movement, participants were asked to keep looking up until we stopped them (Fig. 1). Then each movement was repeated three times and the average value was calculated.

To measure mouth opening range of motion, each participant was seated on a chair with back and neck support; then they were asked to open their mouths as wide as possible. Then the space between upper and lower central incisor teeth was measured with a caliper (Mitutoyo, Japan).

Any trick motion of head movement, such as upper cervical extension was avoided by the physiotherapist (Fig. 2).

Figs 1A and B: Flexion and extension measurement

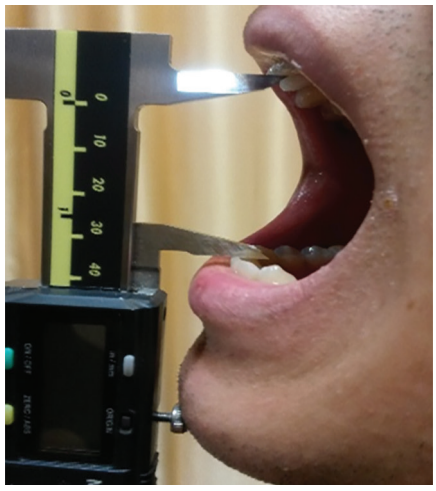

Fig. 2: Mouth opening measurement

Fig. 3: Mouth endurance measurement

In the next step, endurance of mouth was measured and recorded by a dynamometer (Jamar Company, US). For this stage, a stopwatch was used to record timing of the process.

First, each participant was seated on a chair with a good back support and weight of dynamometer was held by participant. Participants were asked to compress arms of dynamometer with their front teeth and to hold dynamometer pointer on 8 to 12 kg. After reaching this static holding position, the time of holding was recorded by the therapist. In the following conditions, time was stopped:

- Any pain and discomfort in masticatory muscles
- Lowering of dynamometer pointer below 8 kg more than five times (Fig. 3)

For measurement of cervical extensor muscles endurance, modified Sorensen test was used. Participants lay prone on a plinth with the head and neck initially supported over the end of the plinth with the arms alongside the body. Straps were used to stabilize the thoracic spine, at the level of the hip, and at the level of the calf muscles to counterbalance the body and to prevent compensation of other parts of the body during the test. A ruler was fixed in front of participants' face. Participants were asked to maintain position of chin tucked with head and neck parallel at a horizontal level. This position was maintained as long as possible but without support of the head.

Participants were reminded about the correct posture and standardized test and position was monitored carefully by an assessor (a physical therapist).

Endurance holding time was recorded with a stopwatch after removing the neck support. Participants were asked to maintain the position of the head steady with the chin retracted and the cervical spine horizontal to the floor (Fig. 4).

Sorensen test was discontinued if:

- Pain or discomfort was reported by participants who complained of severe pain or discomfort in other parts of the body (thoracic spine, interscapular region, and lumbar spine).
- The participant could not maintain the head in the horizontal position. This was determined when subjects' face was in contact more than five occasional contacts with ruler, which was placed parallel with plinth. However, the time taken for the test was 600 seconds but if any participant could stand longer, we have recorded the time.

Fig. 4: Neck endurance test (modified Sorensen)

RESULTS

Sixty participants (30 healthy and 30 patients) were placed in two groups. Kolmogorov–Simonov test showed normal distribution of the values in two groups.

The descriptive statistics for demographic data are shown in Table 1.

There were no statistically significant differences in age or height between groups.

Average results of the tests in two groups are shown in Table 2.

Table 2 demonstrates that the biggest difference is in the neck extensor muscles endurance in which neck

Table 1: Demographic data for the two groups

	Group	*Mean*	*SD*	*p-value*
Height (cm)	Healthy	174/70	5/72	0/551
	TMD	177/16	6/04	
Weight (kg)	Healthy	74/43	7/94	0/487
	TMD	79/28	8/64	
Age	Healthy	22/80	1/60	0/129
	TMD	23/06	1/33	

*Significantly different when compared with healthy controls at p = 0.05; SD: Standard deviation

extensor muscles endurance (547/30) is significantly higher in controls *vs* patients.

In Table 3, dependent t-test was done to compare variables between two groups. In cervical extensor muscles, endurance time was higher in the control group than in the TMD group ($p > 0.05$).

There were statistically significant differences in cervical flexion range of motion in control group *vs* TMD patients, in which flexion was higher in the control group than in the TMD group ($p > 0.05$).

DISCUSSION

In the present study, to evaluate endurance and range of motion, simple clinical methods and easy scoring scales were used and developed in order to answer clinical questions.

There has been presumed that cervical spine and TMD are connected; however, there was little information about the change of masticatory muscles endurance and also neck and jaw range of motion was related to TMD. The priority of physiotherapy program (PT) is restoring the musculoskeletal system of the craniocervical area using exercise or manual therapy techniques.

With TMDs, therapeutic exercise has also been found to be positive in reducing symptoms.[12] However, there is lack of the best therapeutic exercises program to cervical and temporomandibular areas.

Relation of Neck Range of Motion between Two Groups

In the present study, neck flexion range of motion was lower in TMD group when compared with healthy control group. There was no study that checked cervical range of motion in patients with TMD. As previously mentioned, the prevalence of neck pain is high in patients with TMD.[13] On the contrary, range of motion in patients with neck pain was shown to be altered.[14] This project supports the clinical finding regarding relationship between TMD and cervical range of motion. But in this study, range of motion was checked in sagittal plane only, and range of flexion between the two groups was significant.

Nature of this study could not explain a cause and effect relationship, but the result is likely due to the pattern of muscle recruitment and subsequent different areas distribution of neck range of motion.

Cervical Muscle Endurance and TMD

Information on the muscular impairment in the neck area following whiplash injury, cervicogenic headache,

Table 2: Inferential statistics of the variables studied in the two groups

Variable	*Group*	*Mean*	*Standard deviation*	*Maximum*	*Minimum*
Flexion of the head and neck (degree)	Healthy	44/25	3/96	52/3	36/6
	TMD	37/90	2/33	34/3	46
Extension of the head and neck (degree)	Healthy	49/22	3/97	56/3	39
	TMD	48/71	3/05	53/16	42/33
Mouth opening (mm)	Healthy	49/88	8/45	67/89	29/69
	TMD	48/53	6/19	65/27	27/21
Masticatory muscles endurance (seconds)	Healthy	73/90	20/82	120	36
	TMD	69/57	18/93	124	45
Neck extensor muscles endurance (seconds)	Healthy	547/30	71/52	710	380
	TMD	382/30	43/44	439	250

*Independent samples t-test

Table 3: Comparison of TMJ variables between two groups.(N= 30)

	Mean ± SD		
Variable	*Control*	*TMD*	*p-value*
Flexion of the head and neck (degrees)	44/25 ± 3/96	37/90 ± 2/33	*<0/001
Extension of the head and neck (degrees)	49/22 ± 2/97	48/71 ± 3/05	0/577
Mouth opening (mm)	49/88 ± 8/45	48/53 ± 6/19	0/484
Masticatory muscles endurance (seconds)	73/90 ± 20/82	68/57 ± 18/93	0/402
Neck extensor muscles endurance (seconds)	547/30 ± 71/52	382/30 ± 43/44	*<0/001

SD: Standard deviation; *Significantly when $p < 0.05$

and neck pain had been the matter for research for many years.[15,16]

According to "pain adaptation model," muscle pain interacts with motor control, which can be concluded that pattern of muscle activity changes in presence of pain.[17] According to Travell and Simons,[18] functional impairment of myofascial system in masticatory muscles, such as lateral pterygoid causes key muscles dysfunction of neck.[18] Physiological and anatomical relation between jaw and neck area has been proved.[19] This relation is caused by trigeminal and neck afferent fibers which are connected together by trigeminocervical nucleus, so mouth and upper areas of the neck are linked together.

According to neuromuscular pain activation model which was suggested by Sterling et al,[20] presence of pain leads to inhibition of activation of specific muscle groups with a determined action. Changes that occurred in the sensorimotor region in the presence of pain are influenced by individual response and complexity of sensorimotor system.[21] Then some muscles may increase in activity and others may decrease.

The present research showed that endurance of neck extensor muscles in TMD was reduced.[22]

An electromyographic (EMG) study in 2013 showed that neck extensor muscle endurance in patients with TMD was reduced.[5] Our study showed the same result with clinical test and supports relationship between neck muscles and TMD.

Endurance of Masticatory Muscles and the Mouth Opening between the Two Groups

Extensive research has been conducted on the EMG and force characteristics of jaw closing masticatory muscle system. Result of these studies demonstrated that masticatory muscles do not show changes in their brief maximal contraction or force levels during and after various fatigue-inducing isometric tasks.[23]

In a previous study, masticatory muscle thickness and bite force were measured. Low maximal mandibular elevator muscle activity or low bite force was seen in patients with sign and symptoms of TMD.[11]

In the current study, we found that endurance of masticatory muscles was not decreased in TMD patients.

This result shows that masticatory muscle endurance is irrespective of endurance of neck muscle extensors.

Relation of Mouth Opening Range of Motion between Two Groups

In the current results, we found that mouth opening range of motion was not significantly different between the two groups.

These results are in contrast to studies that show changes in range of motion in patients with more severe stages of the disease.[24] The contradictory result is probably due to potential changes of motor strategies in craniocervical area in these patients to compensate for necessary activity.

In summary, previous studies required expensive equipment, e.g., using muscles, EMG was performed in these areas, but in this study we used a simple and less expensive clinical tests; nevertheless, we had similar results. This study demonstrated that our method could cover these requirements.

Our methods can be performed anywhere and anytime without any special or expensive equipment.

In addition, this examination can be prescribed as treatment for TMD patients. It also can be recommended as home program for patients. Altogether, the results of these studies provide a major contribution to the area of PT and exercise prescription for patients with TMD. The results of this study can open a new window on TMD research because it seems necessary to investigate effectiveness of PT programs targeting muscle impairments.

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