AFRICAN JOURNAL OF MEDICINE and medical sciences

VOLUME 29, NUMBER 1, MARCH 2000

EDITOR:
B. O. OSOTIMEHIN

ASSISTANT EDITOR:
A. O. UWAIFO

ISSN 1116 — 4077

Afr. J. Med. med. Sci. (2000) 29, 1-5

Electrical (faradic) stimulation versus active mobilization exercise in the physical management of post-surgical temporomandibular joint hypomobility

A.O. Sanya, A.O. Balogun**, J.T. Arotiba* and T.K. Hamzat****

*Department of Physiotherapy**, Dept of Oral and Maxillofacial Surgery*, College of Medicine, University of Ibadan, Ibadan, Nigeria*

Summary

This clinical study compared the efficacy of faradic stimulation and active mobilization exercises in the physical management of patients with post-surgical immobilization of the temporomandibular joint (TMJ) resulting in hypomobility of the joint. Eight volunteer dental patients with post-surgical immobilization TMJ hypomobility at the University College Hospital (U.C.H.), Ibadan, Nigeria participated in the study. Duration of TMJ immobilization was between 6 and 10 weeks (mean 7.13 ± 1.55). Patients were alternately assigned to two groups as they became available. Patients in group A received mild infra-red radiation to the TMJ region and faradic stimulation to the muscles that move the joint while patients in group B had mild infra-red radiation and TMJ mobilization exercises. Treatment continued until pain relief and full range of the TMJ were attained. However after three treatment sessions, attendance became irregular because the patients were satisfied with their recovery. Pain perception was measured using the visual analogue scale. Interincisal opening was measured using a pair of mathematical set divider and a measuring ruler. The results showed that both faradic stimulation and exercises significantly improved the interincisal opening and pain perception although electrical stimulation improved mouth opening more significantly than active exercise.

Keywords: *Temporomandibular joint, electrical stimulation, active mobilization exercise.*

Résumé

Lette etude clinique avait compare e'efficite de la stimulation faradique et les excercies de unmobilisation actives daus le tractement des patients ayant immobilizationde lar ticulation temporomendibulaise TMJ), reructant de chypomolitie-de larticulation post cliruragicale (TMJ) centre hospitalier univeritaire d'Ibadan Nigeria awaient participe a l'etude. La duree de la l'unmobilisation de la TMJ etait de 6a O semaines (mpyenne 7,13 ±1.55). Les patients etaient di vise en 2 groupes de maniere acterne, an furet a merure qu'ils devenaient disponsible. Les patients daus le groupe a avaient recus line doule radiation a l'infra-rauge a la re gion de l'aricifation temporamendibulaire [TMJ], et une stimulation fadique au musle musle qui soeleve l'articiation. Les patientsune douce dans le groupe Be awaient recusradiation a l'infra-rouge et execerise de mobilisation de l'articulation temporomendibulaire. Le traite continua jusquia la reduction complete de la douleur et l'owuesture uaximate de la TMJ etai attcint. Cependant apies 3 sessions de treatenment, la participation devenouit irreguliere av cause de fait gque le patients etaient satifaits avec leur quesion et commencaient as manguer aux seances. La perpception de la doculeur etait mesure en utilisant l'echalle oisuclle analogue, l'ouverture interinsisure etait mesure en utilisant une parfit du disiseur ma the matique et une regle a mesure.Les results montrent que la taimulation de fardic et les exercises et la paraception douloureure la bouche plus significativement que l'exececrise actif.

Correspondence : Dr. Arinola O.Sanya, Department of Physiotherapy, College of Medicine, University of Ibadan, Ibadan, Nigeria

Introduction

The temporomandibular joint [TMJ] is one of the most complex facial structures, producing in its various pathological states many problems with attendant difficulty in diagnosis and treatment [1]. The TMJ is a diathroidal synovial joint on either side of the skull with two joint movements occurring in separate compartments of the joint and in consonance with each other. Jaw opening is achieved by anterior condylar translation caused mostly by contraction of the lateral pterygoid muscles while jaw closure is brought about by actions of the masseter, temporalis and medial pterygoid muscles [1]. Hypomobility of TMJ affects functions which require voluntary and involuntary opening of the mouth such as eating, talking, oral hygiene and yawning.

The temporomandibular joint disorder as a cause of many clinical symptoms throughout the head and neck is becoming widely recognized among health professionals. Presently the dentist is the primary professional involved in TMJ evaluation and treatment. Others are the rheumatologist and orthopaedist who may not evaluate the TMJ in the same way they evaluate other synovial joints. The major aspects of physiotherapy in dentistry include evaluation of temporomandibular joint disorders and testing of jaw balance by kinesiologic methods [2].

Hypomobility of a joint may result from a variety of disorders affecting the joint and the surrounding structures. Hypomobility of the TMJ often results from trauma, prolonged immobilization, or both. When there is hypomobility of the TMJ, the main jaw opening muscle (lateral pterygoid) is affected because full muscle contraction depends on normal movements of the joint. Other causes of TMJ hypomobility include, myofacial dysfunction, pain, internal derangement of the TMJ, as well as post-traumatic intra or extra-articular ankylosis. Degenerative and rheumatoid arthritis, as well as infections and metabolic TMJ disorders have also been described as causes of hypomobility [3].

Intricate co-ordination of function between the two temporomandibular joints and their components is required

for the variety of movements that can and must be made by the mandible in performing its function of speech, respiration, mastication and deglutition of food. Muscles acting on joints that have been immobilized for a period of time may become atrophied and shortened due to myostatic contracture.

Hypomobility of the temporomandibular joint as a past or presenting problem is a dysfunction often seen in TMJ disorders. In this condition, there is an inability to open the mouth to any appreciable degree. Patients vary in physique and thus the subjective criterion for their functional anterior opening is based on their own knuckles being used as a measure of the widest distance between the upper and lower incisors [4]. If the joints movements are restricted the patient will not be able to insert two knuckles. In objective clinical measurement, the interincisal opening is measured in millimetres, allowing improvement from treatment to be noted. Healthy individuals can typically open the mouth from 35 mm to about 50 mm measured inter-incically.

Therapeutic procedure to increase mandibular range of motion include hot and cold compresses, increasing number of tongue depressors placed between the teeth, midrange jaw resistive exercises and manipulation with the patient under general anaesthesia. These procedures usually resolve the condition although some patients improve slowly or not at all [5]. Electrical stimulation induces muscle contraction either by directly causing muscle depolarization or by stimulation of the peripheral nerve supply. Electrical impulses with a duration of less that 10 milliseconds (ms) classified as having a short duration and are used for stimulating innervated muscles. Such impulses are said to be faradic-type. A faradic type current is a short duration interrupted direct current with a pulse duration of 0.1-1.0 ms and a frequency of 50-100Hz. It is surged to produce a contraction similar to active muscle contraction [6]. Electrical stimulation of muscles can be used to reduce pain and muscle spasm as well as restore neuromuscular balance. Repetitive stimulation may also reduce contractures, improve local circulation and reduce resting electromyographic activity. It is reported to be well tolerated even in the presence of painful conditions [7].

Active exercises are often used as an integral part of treatment following surgery, trauma and immobilization, to restore mobility, function and co-ordination. Exercise therapy has been recommended for the management of clicking, restricted opening due to muscle spasm or contracture, muscle incoordination, irregular mandibular movements and recurrent anterior dislocation of the condyle. It has been suggested that manipulative procedure and muscle exercise should be performed under a pain-free condition, exercise are most often prescribed as part of a more extensive therapeutic programme [5].

Infra-red rays are electromagnetic waves with wave length of between 750 nm and 400,000 nm. When the radiations are absorbed, the radiant energy is converted to heat. It is frequently employed as a means of relieving pain. When heating is mild, the relief of pain is probably due to the sedative effects on the superficial sensory nerve endings [6]. As a result of its analgesic and muscle relaxation effects, infra-red radiation is frequently used as preliminary to other forms of physiotherapy. The physiotherapy modalities used in TMJ hypomobility include superficial heat, cryotherapy, ultrasound, short wave diathermy, massage, exercise therapy and electrical stimulation [6].

This clinical study was carried out to compare the efficacy of faradic-type current (electrical stimulation) and active mobilization exercises on pain and inter-incisal opening of patients with post-surgery temporomandibular joint hypomobility.

Materials and methods

Subjects

The participants in this study included six volunteer males and two volunteer female patients attending the dental clinic of the University College Hospital (U.C.H.), Ibadan, Nigeria. They were specifically referred for physiotherapy for this study by the maxillofacial surgeon as they became available.

They all presented with temporomandibular joint hypomobility post-surgical immobilization of the jaw. Hence, post-surgical immobilization resulting in hypomobility of the temporomandibular joint was the major inclusion criterion for this study. Pain and protective muscle spasm were common clinical features of all the subjects. The low availability of subjects with hypomobility of the TMJ following immobilization of the jaw was responsible for the small number of subjects.

Patients were alternately assigned to either of group A or B as they became available. Patients in group A received mild infra-red radiation and faradic electrical stimulation while group B patients were treated with mild infra-red radiation and active mobilization exercises.

Materials

- A luminous infra-red lamp (Infraphil HP 3690) manufactured by Phillips.
- A pair of sterilized mathematical set dividers.
- A measurement ruler calibrated in millimeters.
- A Visual Analogue Scale (VAS) for assessment of pain.
- Petroleum jelly.
- Warm saline water.
- Two test tubes containing hot and cold water, respectively, were used to carry out thermal skin sensation test to the TMJ region.
- Cotton wool, soap, water and a towel were used to clean the skin of the area for infra-red radiation and electrical stimulation.
- An orange stick was used to carry out tactile sensation test.

Procedure

To measure the degree of active jaw opening, the patient was comfortably seated in a chair and instructed to open the mouth to the widest comfortable extent. The distance between the upper and lower incisors (inter-incisal opening) was measured using a pair of mathematical set dividers. The opening on the part of dividers was then placed on a measuring ruler to record the inter-incisal opening in millimeters to the nearest decimal place. The midline

relationship between the upper and lower incisors was maintained as the jaw opened vertically and any deviation was noted.

Pain intensity was assessed using the visual analogue scale. This scale consisted of a 10 cm straight line which represents the intensity of pain with verbal anchors at the opposite ends representing "no pain" at the lower (zero cm) end and "pain as bad as it can be" at the upper (10 cm) end. This scale has been described as the most probable practical method to use in a clinical situation [8].

After the measurements of interincisal opening and pain perception, skin sensation test to hot and cold was carried out on the areas of the TMJ to be irradiated with infra-red rays (IRR). This test was carried out by putting warm and cold water in two separate test tubes, away from the view of the patient. The patient was instructed to close the eyes and asked to describe the feeling on being touched with the sides of the test tubes. Failure to correctly identify the cold and warm touch would indicate defective skin sensation or impaired blood circulation, which is a major contra-indication to heat therapy.

The procedure of IRR was explained were to the patient after the skin sensation test. Patients was instructed not to tolerate more than comfortable mild warmth from the irradiation and to call the physiotherapist's attention immediately the heating was no longer mild. A strip of water-soaked cotton wool was placed over the closed eyelids of the patient to protect the eyes from the IRR. The remaining parts of the face and head not being treated were covered with a towel to protect against the heat. The infra-red lamp (Infraphil HP3690) was positioned such that it was directly opposite the centre of the temporomandibular joint and the rays striking the joint at a right angle, ensuring maximum absorption of the IRR. The distance between the face and the lamp was adjusted such that very mild intensity of heat was felt by the patient. Each temporomandibular joint was irradiated for 10 minutes.

Group A patients - (electrical stimulation group)
In addition to infra-red radiation, faradic electrical stimulation (using Duffield model electrical stimulator) was used for group A patients. Before the faradic stimulation, tactile skin sensation was tested using an orange stick. This was carried out with the patient closing the eyes and asked to describe points of stroke with the orange stick on the face. On passing this test, the skin area to be stimulated was prepared by cleaning with soap and warm saline water to reduce skin resistance of faradic current. The wound edges on the face were covered with petroleum jelly to prevent concentration of electric current.

A flat plate metal electrode (size 3" by 3") padded with 8 layers of lint (4" by 4") was used as the indifferent electrode while a disc (button) electrode was used as the active electrode. The lint pad was soaked with warm saline water and then wrapped around the flat plate metal electrode before being placed at the back of the neck with the patient in supine lying. The button electrode (covered with lint soaked in warm saline) was used to pick the lateral pterygoid muscle. Contraction and relaxation of the muscle were obtained by surging the faradic current using triangular waveform. The intensity of the current was increased gradually until a perceptible but tolerable contraction of the muscle was obtained. For each treatment session, 100 contractions of muscles (divided into 4 equal segments) were obtained with a resting interval of 3-5 minutes allowed in-between the segments to prevent early fatigue of the stimulated muscle. The study was designed such that treatment would continue until pain relief and full range of motion on the TMJ were attained. It was envisaged that a minimum of 10 treatment sessions would be given to each subject. However, attendance became irregular after about 3 treatment sessions.

Group B patients (active exercise group)
Immediately after the infra-red radiation, each patient in group B was comfortably seated in a back supported upright position. The patient was then instructed to open and close the mouth in a hinge-like movement within the restricted range of motion for a total of 100 times divided into 4 equal segments. A resting interval of 3-5 minutes was allowed in-between each segment to prevent early fatigue of the affected muscles. Each patient in the two groups was asked to assess the pain intensity before and after each treatment session using the visual analogue scale. Inter-incisal opening was also measured before and after each treatment session. Each patient was to have 3 treatment sessions per week until a minimum of ten therapy sessions is attained.

Treatment of Data
Descriptive statistics of range, mean and standard deviation were compared for the pain intensity and range of motion of the TMJ of the patients. Inferential statistics of t-test was used to compare the pre and post-treatment values between and within the 2 groups at 0.05 alpha level of significance. Only the treatment outcome for the first 3 treatment sessions were computed because of very irregular attendance thereafter.

Results
A total of 8 patients with post-surgical temporomandibular joint (TMJ) hypomobility participated in this study. The personal infomation of the patients are as shown in table 1. Their ages ranged from 9 to 39 years (mean 22.75 $\pm$ 0.09). The patients had their TMJ immobilized for a period ranging from 6 to 10 weeks (mean 7.13 $\pm$ 1.55) as shown in table 2.

Table 1: Personal details of patients

S/n	Age (Yrs)	Sex	Occupation	Duration of Immobilization (Wks)
01	9	male	student	6
02	17	male	student	7
03	29	male	business	9
04	39	male	housewife	6
05	34	male	trading	10
06	11	male	student	6
07	23	male	trading	6
08	20	male	student	7

The pain perception ratings for group A patients (electrical stimulation) before treatment ranged between 4 and 8 (mean 5.5 $\pm$ 1.91) and after treatment the pain perception rating was

zero. Interincisal opening in group A patients ranged from 9 to 21 mm (mean 14.87 ± 4.81) before treatment and from 31 to 42 9 (mean 36.25 ± 4.50) after treatment. In group B (exercise group), pain perception rating before treatment ranged between 5 and 7 (mean 6.50 ± 1.0) and between 0 and 1.0 (mean 0.50 ± 0.58) after treatment and between 21 and 30.0 mm (mean 26.0 ± 3.92)interincisal opening ranged from 11.5 to 20.0mm (mean 15.75 ± 3.75 before treatment and after treatment.

The t-test analysis showed significant difference in pain perception ratings of both groups after treatment ($P < 0.05$). Interincisal opening was significantly improved by electrical stimulation and active exercise as shown in Table 3 ($P < 0.05$). The outcome of the t-test carried out between the pre-treatment pain perception of groups A and B showed no significant difference ($P > 0.05$), the same trend was observed ($P > 0.05$) in the posttreatment values of the 2 groups. There was no significant difference in the pre-treatment inter-incisal opening of the 2 groups. However, after treatment, electrical stimulation increased interincisal opening more than active mobilization exercise ($P < 0.05$) as shown in Tables 3 and 4.

Table 2 : Pre-treatment clinical information on patients

	Age (Years)	Duration of imobilization (Weeks)	VAS pain rating	Interincisal opening (mm)
Range	9-39	6-10	4-8	9.0-20.0
Mean	22.75	7.13	6.37	·15..31
S.D.	0.09	1.55	1.30	3.75

Table 3: Mean of pain perception rating and interincisal opening before and after treatment (groups A and B)

	Pain		Inter-Incisal	Opening
	GRP A(n = 4)	GRP B (n = 4)	GRP B (n = 4)	GRP B (n = 4)
	$\overline{X}$ ± S.D	$\overline{X}$ ± S.	$\overline{X}$ ± S.D	$\overline{X}$ ± S.D
Pre-treatment	5.5 ± 1.914	6.5 ± 1.0	14.87 ± 4.8	15.75 ± 3.75
Post-treatment	0.0	0.5 ± 0.5	36.25 ± 4.5	26.0 ± 3.915
t-value	5.747	4.28	23.7	3.18
P level	< 0.05	< 0.05	< 0.05	< 0.05

Discussion

The outcome of statistical analysis carried out in this study indicate that there was significant improvement in pain perception of patients after three physiotherapy sessions using electrical stimulation and active mobilization exercise in the 2 groups of patients. The sedative effect of mild IRR and the improved blood flow caused by IRR and the movements could be responsible for the pain relief in both groups. The significant relief of temporomandibular joint (TMJ) hypomobility pain by electrical stimulation in this study is in line with a previous study [7] which reported that stimulation of muscles around the temporomandibular joint can be used to relieve myofacial pain in patients with TMJ disorders. The relief of pain may have been brought about by reduction of the inhibitory effect on the large anterior horn cells supplying the antagonistic muscles group by electrical stimulation, hereby impeding the transmission of impulses to the motor units [8].

Improvement in pain perception by active mobilization exercise observed in this study may be due to direct effect of repeated free active joint movement by the stimulation of mechanoreceptors which in turn inhibits the transmission of pain impulses from the periphery through the spinal cord to the brain. The removal of metabolites which act as an irritant to the nocioceptive nerve endings in the painful tissue may also be brought about by rythmical movement of the joint which moves fluid through the tissue planes and increasing lymphatic and venous drainage [9].

Inter incisal opening was increased by electrical stimulation in this study in agreement with the findings of a previous study [10] which reported that usage of electrical stimulation as an adjunct in the management of patients with restricted jaw movement and myofacial pain yielded significant results. Active mobilization exercise also increased the interincisal opening of the patients. This is in line with the findings of a previous study [10] that active mobilization exercise is an effective means of improving jaw opening where opening has been restricted for several weeks after fracture or orthognatic surgery.

Infra-red radiation was applied on the TMJ region of subjects in both groups to bring about muscle relaxation and caused pain relief in order that movement (by electrical stimulation or active exercise) will be more comfortable for the subjects. Since both groups received IRR prior to exercise, the mode of exercise could be implied to be responsible for the difference in the outcome of treatment.

Although the study was designed for a minimum of 10 treatment sessions, none of the subjects attended regularly after the third sessions. However their clinical progress was followed up beyond the 3 treatment sessions reported here. The early self-discharge or irregular attendance could be attributed to the fact that by the third treatment session, the patients were satisfied with the reduction in pain perception and increased mobility of the TMJ. As a result of quick recovery coupled with the cost of hospital attendance with particular reference to the ease and cost of transportation, attendance became very irregular.

The small number of subjects in this study was a major limitation. The study size was due partly to the fact that temporomandibular joint hypomobility is not frequently encountered when severe. Also referral of dental patients for physiotherapy is quite uncommon in this hospital [3]. The subjects in this study were specifically referred for the study. The reason for the low referral of patients for physiotherapy for TMJ hypomobility sequel to surgical

Table 4: Comparison of pre- and post-treatment pain perception rating and inter-incisal opening (Groups A & B)

	Pain				Inter-incisal opening			
	A	B			A	B		
	$\overline{X} \pm$ SD	$\overline{X} \pm$ SD	t-value	P level	$\overline{X} \pm$ SD	$\overline{X} \pm$ SD	t-value	P level
Pre-treatment	5.5 ± 1.914	6.5 ± 1.0	0.926	>0.05	14.87 ± 4.81	15.75 ± 3.75	0.288	0.05
Post-treatment	0	0.5 ± 0.58	0.930	>0.05	36.25 ± 4.5	26.0 ± 3.9	3.43	0.05

immobilization at the UCH is not very clear. From this and a previous study by Amosun *et al.* [3], it is seen that some categories of dental surgery patients can benefit immensely from physiotherapy. Inadequate enlightenment on both sides about the role of physiotherapy in dental surgery could also be a factor responsible for poor utilization of physiotherapy services in dental surgery. The additional belief that physiotherapiss work closely with orthopaedic surgeons for the functional rehabilitation of traumatized joint does not seem to apply to , TMJ in this environment in spite of the fact that the physical and functional disabilities of hypomobility of , TMJ is more severe than that of hypomobility of the knee joint for example.

Another possible reason for the small number of of patients included in this study is the relatively high cost of surgical immobilization of the jaw which has to be borne by the patient, since the main inclusion criterion for this study is hypomobility postsurgical immobilization, the cost of surgical immobilization will have effect on the number of patients.

Conclusion

Based on the findings of this study, it was concluded that electrical stimulation and active mobilization exercise are effective modalities in relieving pain and increasing inter-incisal openings in patients with temporomandibular joint hypomobility after dental surgery. Electrical stimulation was however observed to be more effective than mobilization joint hypomobility. It is hereby recommended that electrical stimulation (faradic current) and active mobilization exercise may be employed in management of post surgical TMJ hypomobility.

References

1. Gray RJMA, Clinical approach to temporomandibular disorders classification and function anatomy. Br. Dent J 1994: 176 (11) 429-435.
2. Friedman MH and Weisberg J. Applicaiton of orthopaedic principles in evaluation of the temporomandibular joint. Phys Ther 1982 62 (5) 597-599.
3. Amosun SL, Abiose BO and Durodola OM. Physiotherapy in dentistry - the experience in UCH Ibadan J Nig Soc Physiotherapy 1991: 11; 38-41.
4. Cooper BC and Lucente F E. Craniomandibular Disorder: Management of Facial Head and Neck pain. Philadelphia: WB Saunders Company 1989: 153-160.
5. Friedman MH, Weisberg J and Weber FL. Post-surgical temporomandibular joint hypomobility rehabilitation technique. Oral surg oral med oral pathol. 1993; 75 (1) 24-28.
6. Foster A and Palastanga N. Clayton's Electrotherapy. Theory and practice 9th ed. London:
7. Bailliere Tindall, 1985.7. Selby A. Physical therapy in the management of temporomandibular disorders. Aust Dent J 1985; 30 (4): 273-280.
8. Gaston - Johansson F. Gustafsson M. Rheumatoid arthristis: determination of pain characteristics and comparison of (RAI) Ritchie Articular Index and VAS (Visual Analogue Scale) in its measurement. Pain 1990; 41: 35-40.
9. Thompson A. Skinner A. and Piercy J. Tidy's Physiotherapy 12th Ed. London: Butterworth and Heinemann, 1991: 457-462.
10. Wassberg GA, Carrol WL, Dinham R.and Wolford LM. Transcutanceous electrical stimulation as an adjunct in the management of myofacial pain dysfunction syndrome J Prosthet Dent 1981; 45: 307-313.