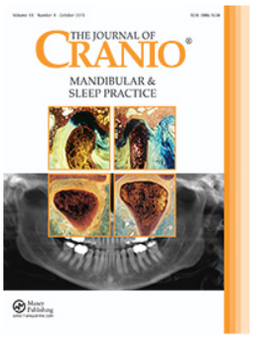

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TMJ

Influence of oral stabilization appliances in intra-articular pressure of the temporomandibular joint

Guillermo Casares[1], Alejandro Thomas[1], Joaquin Carmona[2], Julio Acero[1], Carlos Navarro Vila[1]

[1]Department of Oral and Maxillofacial Surgery, Hospital General Universitario Gregorio Marañón, Madrid, Spain, [2]Private Dental Practice, Madrid, Spain

Aims: This study analyzed the intra-articular pressure in the upper compartment of the temporomandibular joint (TMJ) under different functional conditions. The influence of stabilization appliances on intra-articular pressure was studied.

Methodology: Seventy-four joints from 64 patients (55 women and 9 men; mean age: 43.2±11.86 years; range: 19–61 years) with TMJ disorders were examined. Only 50 joints passed the inclusion criteria. Intra-articular pressure was measured using a 21G needle inserted into the joint and connected to a pressure transducer. Pressure was measured with the jaw in the following positions: at rest, maximal mouth opening, clenching in maximal intercuspal position, and clenching with an oral interoclusal appliance.

Results: Fifty joints were included in the study (without blood reflux), mean pressure at rest was negative (–6.06±4.55 mmHg); when the mouth was opened to its maximal position the pressure was lower (−26.09±6.42 mmHg). Mean intra-articular pressure was higher in the maximal intercuspal position (58.56±24.90 mmHg). When an interoclusal appliance device was fitted, mean intra-articular pressure reduced its value by 31.24%, which reached a mean value of 40.56±18.84 mmHg ($P<0.001$). There were no significant differences in sex. The group over 45 years old had higher pressure values in maximal open mouth position than the group of patients under 45 years old ($P<0.02$).

Conclusions: Interoclusal appliances can reduce pressure in the upper compartment of the TMJ and improve functional status of the joint.

Keywords: TMJ disorders, Oral stabilization appliance, Intra-articular pressure, Synovial fluid, Oral splints

Introduction

The temporomandibular joint (TMJ) can be affected by conditions such as ankylosis, arthritis, trauma, internal derangement disorders, and dislocations. Non-surgical procedures are the most frequent approach to management of patients with TMJ disorders. Long-term follow-up shows that 50–90% of patients have few or no symptoms after conservative treatment.[1]

Oral stabilization appliances support the body's regenerative process and relax masticatory muscles.[2] Intra-articular pressure is a major determinant of joint maintenance and optimal performance.[3] The authors' hypothesis is that oral stabilization appliances can reduce intra-articular pressure, improving the joint function.

This pressure fluctuates during joint activity and depends on several factors: joint angle, joint stress, muscle action, synovial fluid volume, synovial fluid quality, as well as the age, health, and biochemical history of the joint.[4] Joint fluid is essentially a dialysate of blood plasma with the addition of hyaluronic acid, which is produced by synovial cells lining the joint cavity. Changes in synovial fluid volume are reflected by changes in intra-articular hydrostatic pressure.[5]

Measurement of intra-articular pressure has been widely studied in other joints in the body.[5–7] Intra-articular pressure is not constant. There is a change in intra-articular pressure with change in position of the joint. The maximum pressures were generated in the fully flexed position.

Correspondence to: A Thomas, Esquerdo 46, CP 28007 Madrid, Spain. Email: alejthoms@yahoo.es

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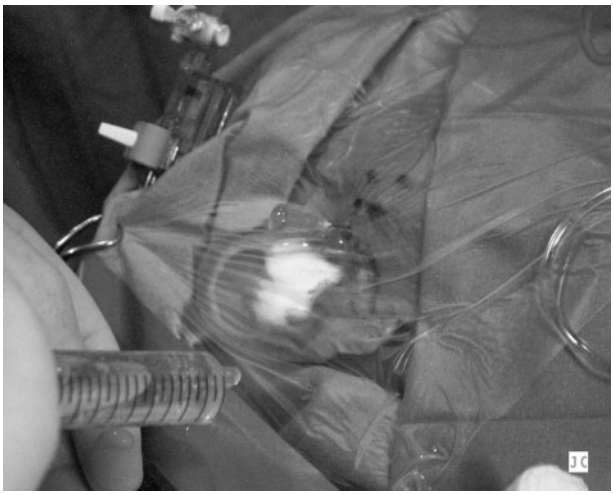

Figure 1 Needle inserted into the joint.

The current study evaluated fluctuations in intra-articular pressure generated in the upper compartment of the TMJ and analyzed the extent to which an interoclusal stabilization appliance influences measurement of these fluctuations, determining if oral stabilization appliances are able to reduce the pressure when the patient is clenching.

Materials and Methods

Subjects

There were 74 joints from 64 patients (55 women and 9 men; mean age: 43.2±11.86 years; range: 19–61 years) with TMJ disorders who were to undergo further therapeutic procedures (arthrocentesis or arthroscopy). Each joint was considered independently.

All patients were diagnosed and treated in the Department of Oral and Maxillofacial Surgery (TMJ Unit) of Gregorio Marañon General Hospital, Madrid, Spain.

According to institutional policy, all patients signed a medical informed consent.

Inclusion criteria

- intra-articular disease of the TMJ (anterior disc displacement without reduction, anterior disc displacement with reduction, intermittent locking, and arthralgia);
- no need for general anesthesia or sedation;
- presence of natural complete dentition;
- absence of dental or periodontal disease interfering with masticatory biomechanical function;
- use of an interoclusal appliance (oral stabilization appliance) for more than 3 months before the therapeutic procedure without symptoms improvement.

In order to determine whether age or sex affected intra-articular pressure, the authors performed an additional analysis by classifying patients as aged under 45 years and aged over 45 years.

Exclusion criteria

Patients who experienced blood reflux could have interference with the intra-articular pressure measurement, and therefore, had to be excluded.

Equipment

The measuring devices used in this study were as follows: a 21G/40-mm intramuscular needle, pressure monitor (Minimon 7173A, Kontron AG®, Germany), chronometer (Casio® Computer Co. GmbH, Germany), and pressure transducer [DTX Plus Transducer Pressure System (pressure range: –50 to +300 mmHg), Ohmeda®; General Electric, UK].

Protocol

The patient was placed in supine decubitus with the head turned contralaterally. Elastic mesh (Mallafix®) and an adhesive (Steri-drape®) were used to move the hair out of the surgical field, the hair close to the surgical field was shaved, the eyes were covered, and the surgical field was disinfected with iodine solution (Betadine®).

Local anesthesia was used (2% lidocaine) to block the auriculotemporal nerve. A second subcutaneous injection was administered without inserting the needle into the TMJ. Once anesthetized, patients could close their mouth and clench their teeth without pain.

Intra-articular pressure was measured using a 21G needle inserted into the TMJ and connected to a pressure transducer. The needle was inserted into the anterolateral part of the fossa in the upper compartment of the TMJ Fig. 1.

Pressure was measured with the jaw in the following positions: at rest, maximal mouth opening, clenching in maximal intercuspal position, and clenching with an interoclusal appliance.

The interoclusal appliance was made of heat-polymerized rigid acrylic resin and was designed using a semi-adjustable articulator (Protar 5B; Kavo Dental®, Charlotte, NC, USA), in which the casts were mounted in the maximal intercuspal position. The oral splint was fitted with contacts for all opposing teeth on the flat surface of the splint. The splint was made for the maxillary arch, and its thickness was 3 mm (Fig. 2). The thickness of the oral appliance was measured with the articulator setting the support pin at +3 position. The final adjustment of the splint from the dental laboratory was performed in the patient's mouth with a drill (STI 7A; Selecdent®, Spain). The occlusal contacts were checked with an articulating paper of 40 μ (Bausch®, Germany) (Fig. 3). The patient was in supine decubitus during the adjustment procedure and was trained to clench with an oral appliance and without it.

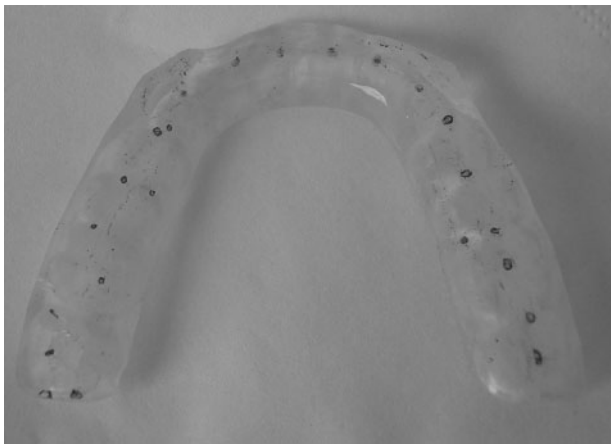

Figure 2 Interoclusal appliance (Michigan splint).

Figure 3 Splint in the mouth.

One reading of each patient was taken without an interoclusal appliance and with an interoclusal appliance to avoid muscle fatigue. The maximal value of pressure was recorded in each patient. Then the therapeutic procedure was performed (arthrocentesis or arthroscopy).

Data were analyzed using the statistical software package SSPS for Windows, version 15.0 (SSPS Inc., Chicago, IL, USA). The results are reported as mean and standard deviations. The results were compared using Student's *t*-test for paired data. The authors applied the Shapiro–Wilk test to confirm that data follow a normal distribution. The group over 45 years old did not follow a normal distribution and used a non-parametric (Mann–Whitney *U*) test.

Results

For the 50 joints included in the study group (no blood reflux), mean intra-articular pressure in the upper compartment of the TMJ at rest was negative (–6.1± 4.5 mmHg), and it was lower when the mouth was opened to its maximal position (−26.1±6.4 mmHg). Mean intra-articular pressure was higher when the patient was clenching in the maximal intercuspal position (58.6±24.9 mmHg) (Table 1) ($P<0.05$).

Table 1 Values for intra-articular pressure in different positions of the joint ($P<0.05$)

	Mean	SD
Rest	–6.060	4.550
MO	–26.900	6.424
MI	58.560	24.904
MIP	40.560	18.847
MI-MIP	18.000	15.123

Note: MO: maximal mouth opening; MI: maximal intercuspal position; MIP: maximal intercuspal position clenching with an interoclusal appliance; MI-MIP: maximal intercuspal position without interoclusal appliance/least maximal intercuspal position clenching with an interoclusal appliance. SD: standard deviation.

When an interoclusal appliance device was fitted, mean intra-articular pressure showed a statistically significant decrease of 31.2%, which reached a mean value of 40.6±18.8 mmHg (Table 2).

There were no significant differences in males and females. The group over 45 years old had higher pressure values in maximal open mouth position than the group of patients under 45 years old ($P<0.02$).

Subjects who experienced blood reflux were eliminated from the study, as it could interfere with the intra-articular pressure measurements.

Discussion

High intra-articular pressure of the TMJ can result in changes in composition and volume of the synovial fluid and contribute to diseases as degenerative arthritis or internal derangement.[8] Some authors believe that oral appliances decompress the TMJ and improve joint function.[2,3,9,10]

There is little evidence on how oral appliances reduce the pressure over the TMJ.[4]

Use of removable oral appliances aims to alter the occlusal relationship, redistribute occlusal forces, prevent wear and mobility of the teeth, treat masticatory muscle pain and dysfunction, alter the structural relationship in the TMJ, and reduce bruxism and parafunction.[11,12]

Table 2 Effect of oral stabilization appliance on the joint. Decrease in pressure value with the patient clenching with an interoclusal appliance ($P<0.001$, *t*-test)

	Sex	Age (years)	*N*	Mean (mmHg)	SD
	Female	<45	25	27.78	28.26
		>45	18	35.18	11.23
	Male	<45	1	17.64	.
		>45	6	36.10	13.82
Total			50	31.24	21.75

Note: SD: standard deviation, *N*: number of patients.

According to the results of the present study, in cases with no blood reflux at the joint, placement of an interoclusal appliance reduced intra-articular pressure by 31.245%, showing that use of an interoclusal appliance reduces intra-articular pressure in the upper compartment of the TMJ.

The results for blood reflux detected during the exploration are excluded. Blood reflux when the needle is removed can interfere with correct measurement of intra-articular pressure due to intra-articular bleeding. Thus, in the opinion of the authors, the results of this subgroup should not be considered valid.

dos Santos and de Rijk[13] used a static mechanical model based on vector analysis to estimate the clenching forces transmitted to the TMJ and concluded that insertion of a stabilizing splint tends to decrease pressure in the joint. In a clinical trial, Ito *et al.*[14] estimated the forces on the TMJ using a jaw-tracking device and concluded that oral stabilization appliances decreased joint load. Nitzan[4] measured the intra-articular pressure at the posterior slope of the eminence in the upper compartment of the joint and analyzed the change in pressure with and without an oral splint. According to Nitzan,[4] the insertion of the splint raises the occlusal plane uniformly, shifts the vector of the bite force distally, and decreases the length of the resistance arm relative to the effort arm, thereby sharply reducing the force directed at the TMJ. While not conclusive, the results of the studies support the decompressing effect of oral appliances.

Kuboki[15] used tomograms of the TMJ to measure the joint space during maximum intercuspation and clenching on two types of splints and found that neither induced any increase in joint space. These findings suggest that these splints do not unload the TMJ.

The two most commonly used appliances in the treatment of TMJ disorders are stabilization appliances and anterior positioning appliances.[16,17]

Anterior positioning appliances are used to decrease joint pain, joint noise, and associated secondary muscle symptoms, which produce intermittent intra-articular blocking. The authors analyzed the behavior of the oral stabilization appliance to reduce intra-articular pressure in the upper compartment of the TMJ.

Stabilization oral appliances, also known as flat planes, oral splints, gnathological splints, or muscle relaxation splints, increase the patient's awareness of jaw habits, and help to alter the rest position of the mandible to a more relaxed open position. These appliances relax the elevator muscles, redistribute forces, protect the teeth, and provide joint stabilization.[18,19]

The reduction of painful symptoms using appliances has been reported,[20,21] although the mechanism is not fully understood, so further studies are needed, supporting the use of this treatment method.[22] Ettlin *el al.*[23] reported that the insertion of a 3-mm-thick occlusal splint led to a change in the topographical condyle–fossa relationship, and therefore, a new distribution of contact areas between joint surfaces.

The authors of this study tried to evaluate whether the use of an interoclusal appliance decreased intra-articular pressure in the upper compartment of the TMJ and, indirectly, if it reduced the stress over the joint.

Several authors have reported intra-articular pressure to be a basic parameter in the evaluation of joint health throughout the body.[24–26] Cartilage requires fluctuating pressure to maintain an adequate blood supply and eliminate waste material.[27,28] Measurement of intra-articular pressure in a healthy relaxed knee has revealed subatmospheric levels similar to those recorded in animals.[3,29,30] In addition, each individual joint has a certain angle at which intra-articular pressure is minimum.[31] This angle is known as the "position of ease" (the posture the patient chooses to reduce tension in injured joint). In the current study, the authors observed, as did Nitzan,[2] that pressure returned to be subatmospheric when the patient rested the jaw. Therefore, the rest position for the TMJ is a "position of ease" in which the least pressure is generated in the upper compartment.

The authors of this study believe that further studies are needed to find out what the ideal intra-articular pressure in the upper compartment of the TMJ is and what pressure is detrimental for the joint.

Disclaimer statements

Contributors

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Conflicts of interest None declared.

Ethics approval Yes, this research was approved by our institution.

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