Analysis of TMJ joint vibration with and without silicon splints in patients with temporomandibular joint hypermobility – a clinical study

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ABSTRACT

Introduction: Temporomandibular joint hypermobility (TMJH) is reported as the risk factor for temporomandibular disorders (TMDs). Joint Vibration Analysis (JVA) is based on simple principles of motion and friction and is used to the objective evaluation of TMJ function, and to assess the effectiveness of TMDs treatment.

Aim: The aim of present study was to analyse of TMJ joint vibration with and without silicon splints in patients with temporomandibular joint hypermobility.

Material and methods: The study comprised fifteen patients with TMJH (12 women, 3 men; mean age 24.2±3.6). The BioJVA Joint Vibration Analysis was compatible with BioPAK Measurement System, and was used for the recording as the electrovibratography. The vibrations were recorded in two sessions (with/without silicon splint) with 15 minutes rest between measurements. IBM SPSS STATISTICS 21 program was used to prepare the statistical analysis. To compare the variables between the conditions (with/without silicon splint), T – test paired – samples were used. Differences were considered statistically significant if the level of probability value was lower than the statistical significance 0.05.

Key words:

joint vibration analysis, joint sounds, temporomandibular joint hypermobility, silicon splints

Results: Mean Total integral quick was significantly lower during splint application measurement in comparison to non-splint measurement for left and right TMJ (mean difference L: 98,013, $p<0.05$; mean difference R: 150,533, $p<0.05$). Mean Ratio of >300/<300 Hz was lower during splint application measurement, in comparison to non-splint measurement for left and right TMJ, but did not quite achieve significance ($p>0.05$).

Conclusions: Application of temporary silicon splints reduces the Total integral quick values in patients with temporomandibular joint hypermobility. The influence of silicon splint application on long-term effects of temporomandibular joint hypermobility treatment requires further research.

Introduction

Temporomandibular joint hypermobility (TMJH), caused by joints ligaments laxity, can manifest a higher range of motion in the mandible [1]. TMJH can be diagnosed when maximum mouth opening (MMO) exceeds 50 mm, and the measurement is taken between upper and lower incisors. Moreover, hypermobility in temporomandibular joint (TMJ) can be divided into three groups: light (50-55 mm MMO), moderate (55-65 mm MMO) and severe (above 65 mm MMO) [2]. The pathogenesis of hypermobility in TMJ is secondary to weakness or laxity of the capsule. However, the etiology of TMJH remains unclear [3]. The activity of masticatory muscles is reduced in relation to the severity of TMJH [1]. In addition, TMJH is more common in women than in man and it is reported as the risk factor for temporomandibular disorders (TMDs) [1,2]. Moreover, patients with a temporomandibular joint hypermobility can present an inability to close the jaw (open lock) after wide opening of the jaw, which results in translation of the condyle beyond the margins of the anterior attachment of the TMJ capsule [4]. TMJH treatment includes conservative (orofacial myofunctional therapy, occlusal splint therapy) and surgical techniques (Norman's procedure, Dautery's procedure) [3,5]. The conventional soft occlusal splint therapy is an effective and recommended mode of a conservative line of the therapy [6].

Joint Vibration Analysis (JVA), based on simple principles of motion and friction, can be used to record and analyze the vibrations occurring in the TMJ [7]. Based on previous results, the JVA technique could measure quantitatively the vibrations from the TMJ with good reliability across two sessions. Thus, JVA can be useful to assess the clinical disorders and to supervise the effectiveness of therapy [8,9].

Aim

The aim of present study was to analyse of TMJ joint vibration with and without silicon splints in patients with temporomandibular joint hypermobility.

Materials and methods

Ethics statement

This study was approved by the ethical committee of the Medical University of Lublin, Poland (KE-0254/331/2015). All patients were informed about the procedures they would undergo and gave their informed consent to participate in the tests.

Subjects description

The study comprised fifteen patients with temporomandibular joint hypermobility (12 women, 3 men; mean age 24.2±3.6). All patients suffer from TMJH manifested at their maximum mouth opening, which was measured by a disposable ruler placed between upper and lower incisors. All patients were classified as TMJH cases with light with MMO of 50-55 mm, according to Nosouhian et al. 2015 [2].

Exclusion criteria: past trauma to the jaw, pain in TMJ or masticatory muscle on palpation, caries or damaged dental tissues, fixed restorations, neuropathic conditions, botulinum toxin therapy, past or ongoing orthodontic therapy.

Measurement plan

Non-splint measurement

The measurements were made with the subjects seated in a dental chair in an upright position (Fig. 1). The BioJVA Joint Vibration Analysis, compatible with BioPAK Measurement System (Bioresearch Inc., Milwaukee, USA), was used for the recording as the electrovibratography as shown in Figure 1. A JVA recording session (containing metronome-guided maximum active 10 open/close movements) was performed.

Splint application measurement

After a 15 minutes recovery period and silicon splint application, the JVA measurement with the same protocol was made. The full arch splint was fabricated for each patient from A-silicone impression material (Elite HD+ Putty Soft Fast Set, Zhermack). Splints were made directly in patients' mouth in centric relation with vertical dimension increased by 3 mm (measured on first premolars), according to Berger et al. [10] (Fig. 1).

Evaluated parameters

The Total integral quick and Ratio of >300/<300 Hz were calculated by the JVA software.

Parameters definitions:

1. Total integral quick (PaHz): a measure of the total energy in the vibration that reflects the intensity of the signal. It is calculated as the area under the curve of the frequency spectrum.
2. The Tatio of >300 Hz/<300 Hz: the ratio between the integral energy >300 Hz divided by the integral energy <300 Hz.

Statistical analysis

IBM SPSS STATISTICS 21 program was used to prepare the statistical analysis. To compare the variables (Total integral quick, Ratio of >300 Hz/<300 Hz) between the conditions (with/without silicon splint), T – test paired – samples were used. Differences were regarded as statistically significant if the level of probability value was lower than the statistical significance 0.05.

Results

As presented in Table 1, mean Total integral quick was significantly lower during splint application measurement, in comparison to non-splint measurement for left and right TMJ (mean difference L: 98,013, $p<0.05$; mean difference R: 150,533, $p<0.05$) [Tab. 1]. Mean symmetry Ratio of >300/<300 Hz was lower during splint application measurement, in comparison to non-splint measurement for left and right TMJ, but did not quite achieve significance ($p>0.05$) (Table 1).

Fig. 1.
The JVA measurement with silicon splint application

Table 1.
Mean total integral quick and Ratio of >300/<300 Hz between non-splint and splint application measurement for left (R) and right (R) TMJ

Muscle	Measurement	n	Mean value	SD	Mean differen-ce	t	p
total integral quick L	*non-splint*	15	144.447	163.355	98.013	2.346	0.034*
	splint	15	46.433	65.675			
total integral quick R	*non-splint*	15	225.607	214.244	150.533	2.849	0.013*
	splint	15	75.073	84.181			
Ratio of >300/<300 Hz L	*non-splint*	15	0.131	0.085	0.019	0.759	0.461
	splint	15	0.112	0.120			
Ratio of >300/<300 Hz R	*non-splint*	15	0.161	0.144	0.075	1.947	0.072
	splint	15	0.085	0.066			

* significant differences (p<0.05)

Discussion

JVA, based on simple principles of motion and friction can be used to record and analyze the vibrations occurring in the TMJ. It can be used to detect internal derangement and to evaluate how well it is adapted [11]. JVA is more sensitive than the manual examination and its quantitative results make it possible to evaluate the progression of the disorders and to monitor the effectiveness of the therapy. Moreover, it is easy, non-invasive and radiation-free diagnostic method.

TMJH is caused by joints ligaments laxity. It can be correlated with hereditary generalized joint hypermobility or result only from environmental factors. TMJH can be diagnosed when MMO exceeds 50 mm measured between upper and lower incisors and can be divided into three groups: light (50-55 mm MMO), moderate (55-65 mm MMO) and severe (above 65 mm MMO) [2]. All of our examined patients were in the first group (light hypermobility). TMJH is not a true TMD. However, it is considered as the risk factor for TMDs and therefore in some cases it should be managed. There are many methods to address TMJH both conservatively (occlusal splints, autologous blood injections, botulinum toxin injections, intermaxillary fixation and others) and surgically (Dautery's procedure, Norman's procedure, disc anchoring). Occlusal splints are commonly used in the treatment of different TMDs. They can be divided into soft and hard occlusal splints. Soft splints can be used immediately after provisional diagnosis with TMD and are supposed to help in distributing the heavy load associated with parafunctional habits [12]. According to some studies, soft splints can be equally good or even better in addressing TMDs than hard splints [13]. In our study, we used JVA to measure and compare TMJ vibrations in patients with TMJ hypermobility with and without soft silicon splint. The splints were fabricated for every patient individually from A-silicone impression material. Silicon splints were made in centric relation with vertical dimension increased by 3mm (measured on first premolars). For every patient two measurements were performed: the first without splint and the second with splint. Mean Total integral quick values were significantly lower at splint application measurement when compared to non-splint measurement for left and right TMJ. Therefore the immediate improvement of TMJ function during the soft splint application can be indicated. However, JVA did not present significant changes of Ratio of >300/<300 Hz values. Congenial study was conducted by Devi J, et al. [14]. Authors compared effectiveness of anterior repositioning splint, centric stabilization splint and soft splint using JVA among other diagnostic methods. Results indicate that soft splints are effective in

decreasing TMJ sounds and vibrations. However, in this study authors did not measured TMJ vibrations during splint application. In addition, participants had different TMD diagnosis (disc displacement with reduction). These aspects impede proper comparison of our studies. In order to evaluate effectiveness of soft splints on TMJH, more studies are needed with longer follow-up time and larger sample size.

Conclusions

1. Application of temporary silicon splints reduces Total integral quick values in patients with temporomandibular joint hypermobility.
2. The influence of silicon splint application on long-term effects of temporomandibular joint hypermobility treatment requires further research.

Acknowledgments

The results of the present study do not constitute an endorsement of the product by the authors or the journal.

Conflict of interest

The authors declare that they have no conflict of interest.

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