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The Effect of Occlusal Relationships on the Occurrence of Sounds in the Temporomandibular Joint

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A B S T R A C T

The aim of this investigation was to determine the influence of occlusal relationships on the occurrence of sounds in the temporomandibular joint. A group of 100 male subjects aged 24–52 years (X = 35.03±6.92) was examined. Analysis of occlusion included determination of the number of existing teeth, number of teeth in occlusion, overbite and overjet, type of occlusion, mediotrusion interferences, relationship of the retruded contact position (RCP) to intercuspal position (ICP), and the amount and direction of sliding from RCP to ICP. Sound was registered by means of a stethoscope and classified according to its character in click or crepitation. Sound was present in 29% of subjects. In 28% of cases it was registered as click and in 2% of cases as crepitation. One subject had simultaneous click and crepitation. The results of the statistical analysis indicate that overbite, type of occlusion, existence of mediotrusion interferences, the relationship of RCP to ICP, and the amount and direction of sliding from RCP to ICP do not have an influence on the occurrence of sounds. The risk of the occurrence of crepitation is significantly increased in the case of the loss of more than 5 teeth, and in the case of horizontal overbite larger than 7.5 mm ($p<0.05$).

Introduction

The role of occlusion in the occurrence of structural and functional disorders of the stomatognathic system has always been a subject on which investigators and clinicians have disagreed. For many years it was considered that occlusal disorders were the predominant etiological cause in the occurrence of temporomandibular dysfunction (TMD)[1–3].

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Although it has been demonstrated that experimental occlusal interferences induces changes in muscular activity, the paths of the mandible and changes in the position of the condyle in the joint, scientific investigations have so far been unable to confirm the indisputable role of occlusion in the occurrence of dysfunction[4–8]. The results of current investigations play down the influence of occlusion, but do not entirely reject it. Special importance is attributed to certain occlusal parameters, which have been proved to have an effect on the structure and function of the other components of the stomatognathic system[10–11].

The changes which occur in the temporomandibular joint (TMJ) are a consequence of increased mechanical loading, i.e. reduced ability of the tissues to resist and adapt. One of the clinical signs of structural variations in the TMJ is sound, which occurs during mandibular movement. A healthy joint does not produce sounds. However as the occurrence of sounds is normal both in dysfunctional patients and asymptomatic populations, it cannot be considered that every joint which produces sounds is pathologically altered[12]. However, the occurrence of sounds indicates the existence of irregularities in the structure or function of the TMJ. Most often sounds are classified as click or crepitation[13]. The etiology of the occurrence of sounds and the role of occlusion has not been entirely clarified.

The aim of this investigation was to determine the effect of occlusal relationships on the occurrence of sounds in the TMJ, i.e. the number of existing teeth, number of occluded teeth, overbite and overjet, type of occlusion, mediotrusion interferences, differences in the position RCP – ICP and the direction and amount of slide from RCP position into ICP, and on the basis of the results to determine the influence of occlusal relationships on the occurrence of functional and structural changes in the TMJ.

Material and Methods

A group of 100 male subjects, aged from 24–52 years (X = 35.03±6.92) was examined. None of the subjects had previously been subjected to therapy for dysfunction of the stomatognathic system. The existence of sounds was registered by means of a clinical examination and auscultation by stethoscope. The subjects were asked to maximally open and slowly close the mouth, during which the eventual occurrence of sounds was recorded and classified in click or crepitation. All subjects had normal range of mandibular movements (maximal opening > 40mm, lateral movements > 7 mm).

The number of exiting teeth was determined by clinical examination, and the number of teeth in contact in the position of maximal intercuspation was registered by articulation paper. Overbite and overjet were measured in the same position. By guiding the jaws from the position of maximal intercuspation into latero-lateral relationship, in which the buccal cusps of the upper and lower lateral teeth were in the same vertical plane, appurtenance to certain type of occlusion was determined. Depending on the contacts on the laterotrusal and mediotrusal side the subjects were categorized into three groups. Canine guided occlusion was determined when the canines were the only teeth in contact on the laterotrusal side, and on condition that there was no contact on the mediotrusal side. When there were contacts of the premolars on the laterotrusal side too, occlusion was defined as group function. If the contacts occurred on the mediotrusal side the subjects were categorized into a group of balanced occlusion.

RCP position was determined by guiding the mandible by chin-point technique,

and fixing by Lucia-jig. By drawing marks in ICP and measuring the movement of the marks in the RCP position, sliding was determined in the anteroposterior, vertical and latero-lateral direction. A precise caliper was used to measure movement.

Description of the variables which describe the status of the temporomandibular joint, and testing of the above hypotheses on the possibility of dependence between them, was performed by means of the program package: Statistica Version 4. Testing of the hypothesis for correlation of variables was carried out by Spearman's correlation. Predictor variables were determined by logistic regression analysis, and a model of their influence on manifest variables has been obtained (clinical sound, click and crepitation).

Results

The investigation included 100 male subjects (age x=35.03±6.92 years, range = 24–52). Descriptions of the analyzed variables are shown in Tables 1 and 2.

Apart from type of occlusion (1 – canine guided, 2 – group function, 3 – balanced occlusion) all variables are binary (0 – not present, 1 – present). Frequency in a particular category also represents the percentage of frequency in the total number of subjects (N=100). 29% of the subjects had a clinically determined sound, in 28% it was a click, and in 2% crepitation was registered. One subject had simultaneous click and crepitation.

The relationship between quantitative and nominal variables is shown by Spearman's correlations (Table 3).

Crepitation occurs in the case of a small number of teeth (25.73 vs. 16.5, $p<0.01$), i.e. in the case of a smaller number of teeth in occlusion (17.5 vs. 9.0, $p<0.05$). Predictor variables were determined by logistic regression (Table 4).

Other observed variables are not predictors of the occurrence of manifest variables. Value b was obtained by logistic regression model, which indicates how many times there was an increase or reduction in the probability of the occurrence of crepitation in relation to the number of teeth and overjet, which are the only two predictor variables. Results of the analysis point to the conclusion that a reduction in the number of teeth by one increases the probability of the occurrence of crepitation (b = –0.505), i.e. that increase in overjet by one increases the probability of the occurrence of crepitation (b = 1.0669) (Table 5).

TABLE 1
MEAN VALUES (X), STANDARD DEVIATIONS (SD), STANDARD ERROR OF MEAN VALUES (SE), RANGE, MEDIAN AND SKEWNESS OF DISTRIBUTION OF QUANTITATIVE VARIABLES

Quantitative variables	X	SD	SE	Range	Median	Skewness
Age of subject	35.03	6.92	0.69	28	33	0.67
Number of teeth	25.55	4.13	0.41	19	26	–0.64
Number of teeth in occlusion	17.34	4.8	0.48	21	18	–0.03
Overbite (mm)	3.8	1.6	0.16	8	3.75	–0.18
Overjet (mm)	3.58	1.46	0.14	8.8	3.7	0.12
RCP-ICP movement vertical (mm)	0.76	0.83	0.08	4	0.5	1.67
RCP-ICP movement right (mm)	0.09	0.27	0.03	2	0	4.63
RCP-ICP movement left (mm)	0.12	0.49	0.05	4	0	6.16
RCP-ICP sagital movement (mm)	0.5	0.5	0.05	2.5	0.5	1.22

TABLE 2
THE FREQUENCY OF SOME CATEGORIES OF NOMINAL VARIABLES

Nominal variable	Category	f (%)
Type of occlusion		
Canine guided occlusion	1	59
Group function	2	26
Balanced occlusion	3	15
Relationship of RCP to ICP		
Two positions mutually conform	0	27
Two positions do not conform	1	73
Clinically established sound		
Clinically no sound	0	71
Clinically present sound	1	29
Click		
Clinically no click	0	72
Clinically present click	1	28
Crepitation		
Clinically no crepitation	0	98
Clinically present crepitation	1	2

TABLE 3
SPEARMAN'S CORRELATION COEFFICIENT

Correlation of variables	Spearman's R	p-value
Number of teeth and crepitation	–0.225	0,0244
Number of teeth in occlusion, and crepitation	–0.223	0.0254

TABLE 4
PARTIAL CORRELATION COEFFICIENT OF THE PREDICTOR VARIABLES FOR THE OCCURRENCE OF CREPITATION

Predictor variables for the occurrence of crepitation	Correlation coefficient
Number of teeth	–0.251
Overjet	0.237
p	0.00056

The logistic regression model predicts cases without crepitation (98.98–100%), but not cases with crepitation in relation to the number of teeth (0%). In relation to overjet it predicts 50% (Table 6).

On the basis of data from the investigation, curves for prediction of crepitation were calculated by logistic regression method (Figures 1 and 2).

The curve of logistic regression analysis of dependence of the occurrence of crepitation in relation to the number of teeth indicates the possibility that the occurrence of crepitation increases after the loss of five posterior teeth (if third molars are not taken into account). The smaller the number of teeth the greater the probability of the occurrence of crepitation.

The curve of logistic regression analysis of the dependence of the occurrence of crepitation in relation to overjet shows that the possibility of crepitation increases when the overjet exceeds 7.5 mm.

Discussion

The etiology of the occurrence of sounds in the TMJ is not clear. Sound occurs due to structural changes in the joint, either because of irregularity of the joint surface, degenerative changes, or even inadequate lubrication by the synovial fluid[14]. The influence of occlusion on the occurrence of sound in the TMJ has not been completely proved, because of the diverse views of investigators. Mongini considers that the forces which arise from occlusal surfaces of the teeth during the period of function are transmitted to the TMJ, and their effect is the result of occlusal characteristics[15]. Structures in the TMJ usually adapt to functional requirements. Remodelation manifests in the form of complex structural and physiological changes, which involve a series of morphological, biochemical and metabolic processes, which make efforts to maintain homeostasis[16]. The fibrous connective tissue which cov-

TABLE 5
MODELS OF LOGISTIC REGRESSION

Dependent variable	Independent variable	Parameters of the logistic regression model y = exp(a+bx)/l+exp(a+bx)		Level of statistical significance
		a	b	
Crepitation	Number of teeth	6.724	–0.505	0.0038
Crepitation	Overjet	–9.015	1.0669	0.0105

TABLE 6
PREDICTION TABLE FOR LOGISTIC REGRESSION

Model	Observed	Predicted by the model		
		without crepitation	with crepitation	% accuracy of prediction
Crepitation – number of teeth	without crepitation	97	1	98.98
	with crepitation	2	0	0.00
Crepitation – overjet	without crepitation	98	0	100.00
	with crepitation	1	1	50.00
Crepitation – no. of teeth, overjet	without crepitation	97	1	98.98
	with crepitation	2	0	0.00

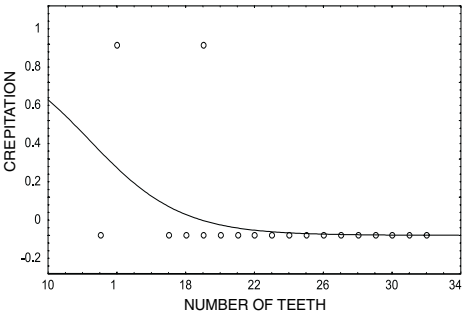

Fig. 1. Dependence of the occurrence of crepitation in relation to the number of teeth.

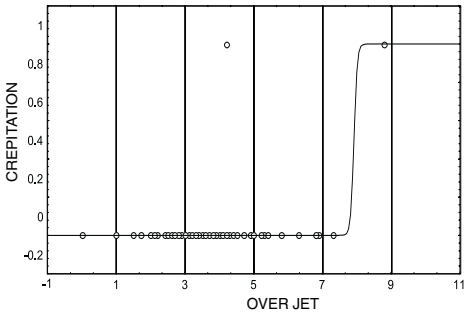

Fig. 2. Dependence of the occurrence of crepitation in relation to overjet.

ers the joint surface in the TMJ has greater ability of self-regeneration than other joints with hyaline cartilage on the surface. Absence of supply and overloading, however, can cause degenerative changes, particularly in the form of fat degeneration and fibrous transformation[17,18]. The osseous tissue of the TMJ is exposed to constant reconstruction and formation of new tissue by means of the progressive exchange of primary bones by osteons of secondary generations. The process is preceded by osteoclastic resorption, after which the lamellas of the new bone are positioned concentrically. If the process remains within the original dimensions only biomechanical and biochemical changes are observed. In some cases the formation of new bone may be more intensive, leading to changes in the form of

the affected structure. Because of the prevalence of resorption and apposition, progressive or regressive remodelation can be differentiated[16]. Changes in form need not necessarily mean the occurrence of symptoms, i.e. pathology. However, clinical signs of structural changes may occur, of which the most frequent is sound.

There are two basic mechanisms which may explain the occurrence of sounds in the TMJ. Click can be the consequence of disturbed condyl-disk relationship, which occurs because of damage to fibers of the posterior ligament, i.e. hyperfunction of the upper belly of the ipsilateral musculus pterygoideus lateralis, and crepitation is usually the result of irregular joint surfaces, most frequently due to degenerative changes[19].

Out of the total number of 100 subjects sound was registered in 29% of cases: in 28% click and in 2% crepitation. In one subject click and crepitation were simultaneous registered. The results corroborate values from literature. In a Lapp population Helkimo registered sound in 32–45% of cases[20,21]. In students from a medical school Schiffman found click in 20% and crepitation in 6%[22]. In an epidemiological study of a population in Saudi Arabia Nourallah found sound in 36% of cases[23]. In a male population in Sweden aged 25–50 years, Agerberg found click in 20% of cases and crepitation in 3%[24].

Reviews of literature and recent studies do not strongly support the role of occlusion on TMD. It has been suggested that these occlusal factors that are more prevalent in patients i.e. large overjet, minimal overbite, occlusal slides greater than 2mm, lack of firm posterior tooth contact are possibly the result of condylar positional changes following intracapsular alterations associated with disease. Therefore, these occlusal factors may be the result, not the cause, of disease[25,26].

The results of this investigation indicate that the majority of occlusal parameters do not play a role in the occurrence of sound in the TMJ. The existence of difference between the positions of RCP and ICP, and eventual anteroposterior, vertical or lateral sliding from RCP into ICP does not have an influence on the occurrence of sounds. The same is true for type of occlusion, mediotrusion interferences and overbite.

The number of teeth present and the amount of overjet influence the occurrence of crepitation ($p<0.05$). The results agree with data from literature. Christensen concluded that mediotrusion interferences do not influence the occurrence of sounds[27], and Westling considers that unilateral contact in RCP is not an etiological factor in the occurrence of change within the TMJ[28].

In his investigation Riolo concluded that excessive overjet induces changes in the TMJ, which agrees with the results of the present investigation[29].

Pullinger carried out a logistic regression analysis with the object of determining the influence of occlusal relations on the occurrence of dysfunction of the stomatognathic system and concluded that only certain occlusal parameters have an influence on the occurrence of osteoarthrosis in the TMJ; sliding from RCP into ICP larger than 2 mm, overjet larger than 6 mm, loss of more than five lateral teeth and overbite larger than 4 mm. He assumed, however, that the high value of overbite in the subjects with clinical sound was a consequence of condylar autoreposition, due to advanced osteoarthrosis and not the cause of its occurrence[30].

By the same statistical method similar conclusions were made in this investigation. Namely, a reduction in the number of teeth below 23, and overjet above 7.5 mm increased the probability of the occurrence of crepitation. As the value of

the number of existing teeth decreased (b = –0.505), and overjet increased (b = 1.067) the probability of the occurrence of crepitation increased.

In his investigation Bargija confirmed a higher frequency of the occurrence of sound in the TMJ, in cases of loss of posterior teeth[31]. Žabarović and coworkers demonstrated that loss of teeth does not have a significant influence on change in articular eminence inclination[32]. MacDonald and Hannam found that collapse of bite due to the loss of teeth increases the risk of the occurrence of tissue changes in the joint[33,34].

Conclusion

Overjet, difference in the position of RCP-ICP; sliding from RCP into ICP, and type of occlusion, i.e. mediotrusion interferences, do not have an influence on the occurrence of sound in the TMJ.

A reduction in the number of existing teeth (by more than 5) and the number of teeth in occlusion, have an influence on the occurrence of crepitation. The occurrence is explained by the loss of the supportive zone and increased functional loading of the joint structure, which during the time leads to degenerative changes which clinically manifest as crepitation.

If the value of overjet increases above 7.5 mm the probability of the occurrence of crepitation is significantly increased. However, it is difficult to determine whether large overjet is the cause or consequence of condylar autoreposition due to osteoarthrosis in the TMJ. Only a longitudinal study will provide definite confirmation.

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UTJECAJ OKLUZIJSKIH ODNOSA NA POJAVU ZVUKA U TEMPOROMANDIBULARNOM ZGLOBU

S A Ž E T A K

Cilj je ovog istraživanja bio utvrditi utjecaj okluzijskih odnosa na pojavu zvuka u temporomandibularnom zglobu. Ispitivanu je skupinu činilo 100 ispitanika muškog spola, dobi od 24 do 52 godine (X = 35.03±6.92). Okluzijska je analiza obuhvatila određivanje broja prisutnih zuba, broja zuba u okluziji, vertikalnog preklopa i horizontalnog pregriza, okluzijskih koncepcija, mediotruzijskih interferenci, razlike između retrudiranog kontaktnog položaja (RKP) i interkuspidacijskog položaja (IKP), te iznosa i smjera klizanja iz RKP u IKP. Zvuk je registriran stetoskopom, te klasificiran obzirom na karakter kao klik, odnosno, krepitacija. Zvuk je bio prisutan u 28% ispitanika, u 27% slučajeva registriran je klik, a u 2% slučajeva krepitacija. Jedan je ispitanik istovremeno imao klik i krepitaciju. Rezultati statističke analize upućuju na zaključak da vertikalni preklop, vrsta okluzijske koncepcije, postojanje mediotruzijskih interferenca, odnos položaja RKP-IKP, te iznos i smjer klizanja iz RKP u IKP ne utječu na pojavu zvuka. Značajno se povećava rizik pojave krepitacije kod gubitka više od 5 zuba, te kod horizontalnog preklopa većeg od 7.5 mm ($p<0.05$).