ACTA
STOMATOLOGICA
CROATICA
www.ascro.hr

Acta stomatol Croat. 2016;50(1):116-121.
DOI: 10.1564/asc50/2/3

IZVORNI ZNANSTVENI RAD
ORIGINAL SCIENTIFIC PAPER

Samir Čimić, Matea Žaja, Sonja Kraljević Šimunković, Marijan Kopić, Amir Ćatić

Utjecaj okluzijske interference na položaj mandibularnog kondila

Influence of Occlusal Interference on the Mandibular Condylar Position

Stomatološki fakultet Sveučilišta u Zagrebu
University of Zagreb School of Dental Medicine

Sažetak

Svrha ovog istraživanja bila je procijeniti utjecaj umjetne okluzijske interference na položaj kondila. **Materijali i postupci:** U istraživanje je bilo uključeno deset ispitanika. Sva mjerenja položaja kondila obavljena su ultrazvučnim mjernim uređajem za snimanje kretnji donje čeljusti na temelju šest stupnjeva slobode. Paraokluzijska žlica bila je pričvršćena na donji zubni niz, a od kompozita napravljena je umjetna okluzijska interferenca na drugom donjem lijevom pretkutnjaku debljine 1 mm. Mjernim uređajem izmjerena su kondilarna odstupanja položaja okluzije s umjetnom okluzijskom interferencom. Kondilarni položaji utvrđeni su prema Kartezijevu koordinatnom sustavu. Sva odstupanja mjerena su prema referentnom položaju maksimalne interkuspidacije. Iz vrijednosti Kartezijeva koordinatnog sustava dobivene su vrijednosti linearnog odstupanja kondila između referentnog položaja i položaja okluzije s umjetnom okluzijskom interferencom. **Rezultati:** Prosječni superiorni pomak kondila iznosio je 0,17 mm (SD 0,39). Prosječno linearno odstupanje između položaja maksimalne interkuspidacije i položaja okluzije s umjetnom okluzijskom interferencom iznosilo je 0,48 mm (SD 0,29, min. 0,17 mm, maks. 1,19 mm). **Zaključak:** Okluzijske interference rezultiraju neposrednim promjenama u položaju kondila u temporomandibularnom zglobu. Utvrđeni prosječni superiorni položaj kondila govori u prilog stvaranju poluge unutar stomatognatog sustava. Rezultati se moraju interpretirati u sklopu ograničenja ove studije (neposredno mjerenje položaja kondila). Za spoznaje o progresiji položaja kondila pri okluzijskoj interferenci preporučuju se nove studije.

Zaprimljen: 27. prosinca 2015.
Prihvaćen: 19. travnja 2016.

Adresa za dopisivanje
Samir Čimić
Sveučilište u Zagrebu
Stomatološki fakultet
Zavod za mobilnu protetiku
Gundulićeva 5, 10000 Zagreb,
Hrvatska
tel: +3851 4802 125
scimic@sfzg.hr

Ključne riječi
zubna okluzija; mandibularni kondil; temporomandibularni zglob

Uvod

Temporomandibularni poremećaji (TMD) definirani su kao stanja s poremećenom, nekompletnom ili oštećenom funkcijom temporomandibularnog zgloba (1). Obuhvaćaju različitu skupinu poremećaja. U studijama je istaknuta različita prevalencija TMD-a u populaciji (2 – 5). Progiante i suradnici (4) ustanovili su kod 36,2 posto ispitivane populacije prisutnost TMD-a boli, a 5,1 posto ispitanika pokazalo je značajne limitacije funkcije povezane s boli. Povezanost okluzije i TMD-a kontroverzna je tema u stomatologiji. U studijama je utvrđena konzistentna povezanost određenih obilježja okluzije i TMD-a (6). U dijelu dostupne literature ističe se povezanost okluzijskih čimbenika i bruksizma (7, 8). I dalje su podijeljena mišljenja postoji li uzročna veza između okluzijske interference i različitih oblika TMD-a, iako je mnogo epidemioloških studija o njihovoj uzajamnoj povezanosti. U praksi se većina stomatologa slaže da interference imaju određeni udjel u nastanku i progresiji različitih oblika TMD-a (9), te da ireverzibilna okluzijska terapija (selektivno ubrušavanje) ima svoju vrijednost i primjenu kod pacijenata s TMD-om (10).

Introduction

Temporomandibular disorders (TMD) are defined as conditions producing abnormal, incomplete, or impaired function of the temporomandibular joint(s) (1). They comprise a diverse group of disorders. Some studies show different prevalence of TMD within population (2-5). In a study performed by Progiante et al (4), 36.2% of the population had some degree of TMD pain, wherein 5.1% of the population had severe limitations due to pain. The issue of relationship between dental occlusion, and temporomandibular disorders (TMDs) is a controversial topic in dentistry. Some authors have reported a consistent association between some occlusal factors and TMD (6). Other studies also confirmed the association between occlusal factors and bruxism (7, 8). Although a large number of studies on the relationship between the occlusal interferences and different types of TMDs have been carried out, there have been opposing opinions regarding the causal relationship between them. Most of the clinicians treating TMD agree that occlusal interferences have certain role in occurrence and progression of different types of TMDs (9), and that irreversible occlusal therapy (se-

Malo je studija u kojima se na ispitanicima proučavao položaj lijevoga i desnoga kondila tijekom različitih okluzijskih nepravilnosti. Uređaji za snimanje kretnji donje čeljusti na temelju šest stupnjeva slobode omogućuju dobivanje informacija o preciznom položaju cijele donje čeljusti te se njima stručnjaci standardno koriste pri istraživanju anatomije i funkcije donje čeljusti (11 – 13). Obrez i Gallo (14) zaključili su da je tek razvojem trodimenzionalnih uređaja za snimanje kretnji donje čeljusti sa sofisticiranom matematičkom transformacijom dobivenih podataka, omogućena relativno precizna procjena kretnji kondila.

Svrha ovog istraživanja *in vivo* bila je na ispitivanom uzorku odrediti utjecaj okluzijske interference na položaj kondila unutar temporomandibularnog zgloba primjenom elektroničkog ultrazvučnog mjernog uređaja.

Materijali i postupci

Ispitanici

U istraživanju je sudjelovalo deset potpuno ozubljenih ispitanika (osim umnjaka) bez znakova i simptoma temporomandibularnih poremećaja (prosjek dobi 26,0 ± 3,7) i bez prethodne ortodontske terapije. Ispitanici su imali *Angle klasu I* za odnos prvih kutnjaka, bez križnoga ili otvorenog zagriza i bez većeg restorativnog zahvata. Pri uključivanju u terapiju svaki ispitanik potpisao je informirani pristanak za sudjelovanje u istraživanju koje je odobrilo Etičko povjerenstvo Stomatološkog fakulteta Sveučilišta u Zagrebu.

Mjerenja

Mjerenja su obavljena ultrazvučnim uređajem za snimanje kretnji donje čeljusti (Arcus Digma II, Kavo, Biberach, Njemačka) koji radi na principu šest stupnjeva slobode. Mjerni uređaj ima transmitere koji se paraokluzijskom žlicom pričvršćuju na donji zubni niz i senzore na obraznom luku koji se pričvršćuju na glavu ispitanika (slika 1.). Na taj način mjeri vremenska odstupanja između emitiranih i prihvaćenih ultrazvučnih signala. Na temelju šest stupnjeva slobode uređaj elektronički izračunava prostorni položaj kondila, sagitalne incizalne točke i/ili odrednice okluzije, ovisno o korištenom modulu.

Najprije su svakom ispitaniku uzeti alginatni otisci (Aroma Fine Plus, GC, Tokio, Japan) kako bi se na sadrenom modelu, prema uputama proizvođača, izradila paraokluzijska žlica iz svjetlosnopolimerizirajućeg akrilata (Unitray, Polident, Volčja Draga, Slovenija). U sljedećem posjetu obavljena su mjerenja ultrazvučnim uređajem za snimanje kretnji donje čeljusti na temelju šest stupnjeva slobode. Svaki ispitanik sjedio je udobno u stolcu (uspravna postura). Paraokluzijska žlica pričvršćena mu je na donji zubni niz s pomoću akrilata za izradu privremenih nadomjestaka (Structur, Voco, Cuxhaven, Njemačka). Paraokluzijska žlica nije bila u doticaju s gornjim zubima u maksimalnoj interkuspidaciji ni u lateralnim kretnjama, te je bila čvrsto vezana na donji zubni niz. Nakon pričvršćivanja paraokluzijske žlice, na glavu ispitanika postavljen je obrazni luk (slika 1.). Mjerenja su obavljena prema uputa-

lective grinding) has its value and application in patients with TMD (10).

Literature findings about clinical measurement of the condylar position at various occlusal irregularities are scarce. Jaw tracking devices with six degrees of freedom allow learning about accurate lower jaw position and kinematics, and are standardly used in investigation of anatomy and function of the lower jaw (11-13). Obrez and Gallo stated that a relatively accurate assessment of condylar position has been possible since the development of a three-dimensional device for mandibular recording with sophisticated mathematical transformation of the obtained data (14).

The aim of this *in vivo* study was to determine the influence of occlusal interference on the condylar position within the temporomandibular joint, on studied sample using electronic ultrasonic recording device.

Materials and Methods

Participants

This study included 10 completely dentate subjects (apart from third molars) without signs and symptoms of the TMD (mean age 26.0 ± 3.7 years), and without previous orthodontic therapy. The subjects had Angle's class I relation of the permanent first lower molar, without crossbite/openbite and without previous extensive restorative treatment. In order to participate in the present study, the participants gave their signed written informed consent approved by the Ethics Committee of the School of Dental Medicine University of Zagreb.

Recordings

All recordings were obtained using an ultrasonic jaw tracking device with six degrees of freedom (Arcus Digma II, Kavo, and Biberach, Germany). A recording device has transmitters which are attached to the lower jaw by means of a paraocclusal tray, and sensors which are attached to the head by means of a facebow (Figure 1). The recording device measures the real-time latency period between transmitted and received ultrasonic impulses. Based on the six degrees of freedom concept, software of the device calculates spatial position of the condyles, sagittal incisal point and/or occlusal determinants, depending on the module of the device.

Irreversible hydrocolloid impressions (Aroma Fine Plus, GC, Tokyo, Japan) were made for each subject, and individual paraocclusal trays were fabricated on stone casts using light curing acrylic resin (Unitray, Polident, Volčja Draga, Slovenia) according to the manufacturer's instructions. At the next appointment, recordings were made using the ultrasonic jaw tracking device with six degrees of freedom. Each participant was seated comfortably in a chair (upright posture). A paraocclusal tray was fixed on the lower teeth using acrylic resins for temporary restorations (Structur, Voco, and Cuxhaven, Germany). The paraocclusal tray was firmly fixed to the lower teeth, and it was not in contact either with the upper teeth in the maximum intercuspation position or during the jaw movements. After the paraocclusal tray fixation, the facebow was mounted (Figure 1). Recordings were made using

ma proizvođača u modulu uređaja *Electronic Position Analysis* (slika 2.). Nakon što je namješten obrazni luk, registriran je položaj maksimalne interkuspidacije kao referentni položaj prema kojemu će se mjeriti odstupanja kondila. Kompozitom je nadograđena umjetna okluzijska interferenca na drugom donjem lijevom pretkutnjaku na potpornoj kvržici (Tetric EvoCeram, Ivoclar Vivadent, Schaan, Lihtenštajn) i to u sloju od 1 mm. Kompozit je polimeriziran (bez upotrebe adheziva zbog lakšeg skidanja kompozitnog materijala). Zatim su izmjerena odstupanja kondila (modulom *Electronic Position Analysis*). Ispitanici su morali zagristi, te je snimljen kondilni položaj pri okluziji s umjetnom okluzijskom interferencom na drugom donjem lijevom pretkutnjaku.

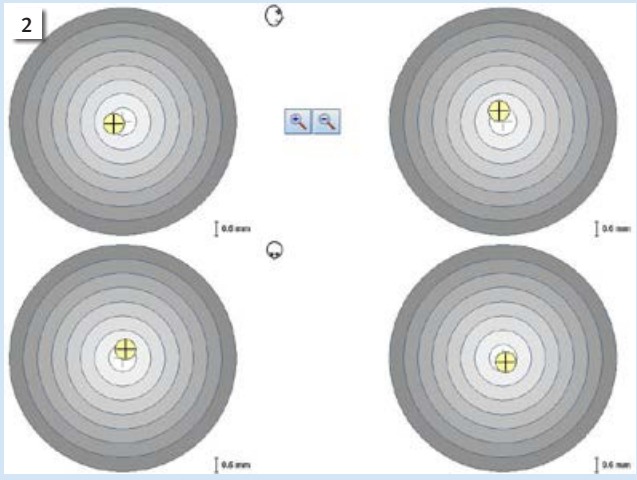
U sklopu računalnog programa *Kavo Integrated Desktop* izračunata su odstupanja zabilježenih položaja lijevoga i desnoga kondila: odstupanje na razini anteroposteriorne osi (**x**), odstupanje na razini vertikalne osi (**y**) i odstupanje na razini lateralne osi (**z**). Odstupanja na razini lijevoga i desnoga kondila tretirana su kao jedan uzorak, kao u sličnim studijama. Osim odstupanja na razini osi Kartezijeva koordinatnog sustava, izračunata su i linearna odstupanja između položaja kondila u maksimalnoj interkuspidaciji i položaja kondila pri okluziji s umjetnom okluzijskom interferencom. Izračunata je i deskriptivna statistika utvrđenih rezultata (SPSS Statistics 17.0).

the software module 'Electronic Position Analysis', according to the manufacturer's instructions (Figure 2). After mounting of the facebow, the maximum intercuspation position was recorded as the reference position for measurements of the condylar position. Using composite resin (Tetric EvoCeram, Ivoclar Vivadent, Schaan, Lichtenstein) an artificial occlusal interference was created on the lingual cusp of the lower left second premolar using composite resin with layer thickness of 1 mm, and polymerized without application of adhesive (for easier removing of the composite resin). Subsequently, the condylar deviations were measured (module 'Electronic Position Analysis'). The subjects had to bite, and the condylar position was recorded at occlusal position defined by the contact with the artificial occlusal interference on the lower left second premolar.

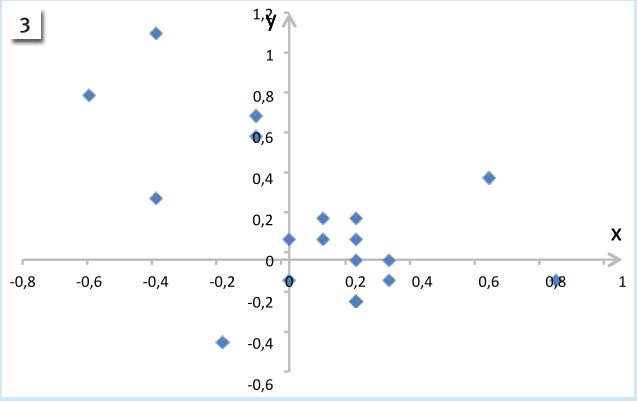
Using the corresponding computer program (Kavo Integrated Desktop) deviations of the recorded left and right condylar positions were measured: deviation at anteroposterior axis (x), deviation at vertical axis (y) and deviation at lateral axis (z). Deviations of the left and the right condylar position were treated as one sample, much like in similar studies. Apart from the deviations at the axes of the Cartesian coordinate system, the linear deviations between the condylar position at the uninterrupted maximum intercuspation and the condylar position during bite with artificial occlusal interference were also determined. Descriptive statistics (SPSS Statistics 17.0) was used to analyze the obtained results .

Slika 1. Namješten kinematski obrazni luk, paraokluzijska žlica, emiteri i senzori uređaja za snimanje kretnji donje čeljusti na temelju šest stupnjeva slobode
Figure 1 Mounted kinematic face-bow, paraocclusal tray, emitters and sensors of the jaw tracking device with six degrees of freedom.

Slika 2. Prikaz modula *Electronic Position Analysis*
Figure 2 Software module 'Electronic Position Analysis'.



Slika 3. Odstupanje između položaja maksimalne interkuspidacije i položaja okluzije s umjetnom okluzijskom interferencom na razini osi **x** (anteroposteriornoj) i **y** (vertikalnoj) za lijevi i desni kondil zajedno (n = 20)
Figure 3 Deviations between the position of maximum intercuspidation and the position of occlusion with artificial occlusal interference at the level of x (anteroposterior) and y (vertical) axis for left and right condyles together (n=20).



Rezultati

Tablica 1. pokazuje iznos odstupanja između položaja maksimalne interkuspidacije i položaja okluzije s umjetnom okluzijskom interferencom za lijevi i desni kondil zajedno (n = 20), na razini osi x (anteroposteriornoj), y (vertikalnoj) i z (lateralnoj). Na slici 3. vide se odstupanja na razini osi x (anteroposteriornoj) i y (vertikalnoj) kod svih ispitanika za lijevi i desni kondil zajedno (n = 20). Tri ispitanika imala su identičnu vrijednost odstupanja kondila (x = 0,2; y = -0,2). Prosječno linearno odstupanje kondila između položaja maksimalne interkuspidacije i položaja okluzije s umjetnom okluzijskom interferencom iznosilo je 0,48 mm (SD 0,29, min. 0,17 mm, maks. 1,19 mm). Tablica 2. prikazuje smjer odstupanja kondila između položaja maksimalne interkuspidacije i položaja okluzije s umjetnom okluzijskom interferencom na drugom donjem lijevom pretkutnjaku.

Results

Table 1 shows the values of deviations between the maximum intercuspation position and the position of the occlusion with artificial occlusal interference, for the left and the right condyle together (n=20), at the x (anteroposterior), y (vertical) and z (lateral) axis. Figure 3 shows deviations at the x (anteroposterior) and the y (vertical) axis for all participants for the left and the right condyle together (n=20). Three participants had identical values (x=0.2; y=-0.2) of condylar deviations. The average condylar linear deviation between the maximum intercuspation position and the position of the occlusion with artificial occlusal interference was 0.48 mm (SD 0.29, min 0.17 mm, max 1.19 mm). Table 2 shows direction of the condylar deviation between the maximum intercuspation position and the position of the occlusion with artificial occlusal interference on the lower left second premolar.

Tablica 1. Iznos odstupanja između položaja maksimalne interkuspidacije i položaja okluzije s umjetnom okluzijskom interferencom za lijevi i desni kondil zajedno (n = 20).
Table 1 Deviation measurement value between the position of maximum intercuspidation and the position of occlusion with artificial occlusal interference for right and left condyles together (n=20).

	Minimum	Maximum	Prosječna vrijednost • Average	SD
Anteroposteriorno odstupanje • Anteroposterior deviation	-0.60	0.80	0.08	0.33
Vertikalno odstupanje • Vertical deviation	-0.40	1.10	0.17	0.39
Lateralno odstupanje • Lateral deviation	-0.20	0.40	0.08	0.16

Tablica 2. Prikaz smjera odstupanja između položaja maksimalne interkuspidacije i položaja okluzije s umjetnom okluzijskom interferencom (n = 20).
Table 2 Direction of the deviation between the position of maximum intercuspation and the position of occlusion with artificial occlusal interference (n=20).

	Antero-superiorni smjer • Antero-superior direction	Postero-superiorni smjer • Postero-superior direction	Antero-inferiorni smjer • Antero-inferior direction	Postero-inferiorni smjer • Postero-inferior direction	Anteriorni smjer • Anterior direction	Superiorni smjer • Superior direction	Inferiorni smjer • Inferior direction	Posteriorni smjer • Posterior direction
N	5	5	5	1	2	1	1	0

Rasprava

U ovom istraživanju proučavao se položaj kondila unutar temporomandibularnog zgloba kod okluzije s umjetno izazvanom okluzijskom interferencom. Utvrđen je prosječno superiorni položaj kondila pri okluziji s okluzijskom interferencom na drugom donjem lijevom pretkutnjaku, uz prosječno linearno odstupanje od 0,48 mm (SD 0,29).

Safari i suradnici (15) proučavali su povezanost prematurnih okluzijskih kontakata i bruksizma, te su ustanovili povezanost mediotruzijskih okluzijskih interferenca i bruksizma. U drugoj studiji, onoj Manfredinija i suradnika (8), istaknuti su djelomična povezanost kliza u centrik, laterotruzijskih interferenca i molarna asimetrija s bruksizmom. Iz dijela literature (16, 17) jasno je da se određeni autori ne slažu s povezanošću mediotruzijskih / laterotruzijskih okluzijskih interferenca i TMD-a. Ipak, iz malobrojnih studija o funkciji kondila i donje čeljusti pri uvođenju umjetnih okluzijskih

Discussion

The study investigated condylar position within temporomandibular joints at occlusion with artificial occlusal interference. On average, superior condylar position during occlusion with occlusal interference at lower left second premolar was determined, with average linear deviation of 0.48 mm (SD 0.29).

Safari et al. (15) studied premature occlusal contacts and bruxism, and found links between nonworking occlusal interferences and the bruxism. Manfredini et al (8) found a partial relationship between bruxism and slide from the retruded contact position to maximum intercuspation, laterotrusion interferences and molar asymmetry. Some authors (16, 17) found no relationships between nonworking/working interferences and TMD. Nevertheless, based on a few studies conducted on the function of the condyle and lower jaw with artificial occlusal interferences, it can be concluded that man-

interferenca može se zaključiti da se nastankom interferenca pojavljuju promjene u funkciji donje čeljusti (18, 19). Huang i suradnici (18) proučavali su utjecaj laterotruzijskih interferenca na kretnje kondila radne strane. Autori (18) su zaključili da laterotruzijske interference značajno neposredno utječu na kretnje kondila radne strane. Huang i suradnici (18) istraživali su utjecaj okluzijskih interferenca na lateralne kretnje, a u ovom istraživanju proučavale su se interference u položaju maksimalne interkuspidacije. Ipak, s obzirom na utvrđene razlike (tablica 1.), rezultati istraživanja Huanga i suradnika (18) mogu se smatrati sličnima onima u ovoj studiji. Može se zaključiti da se nastankom okluzijskih interferenca pojavljuju promjene u kondilarnom položaju tijekom lateralnih kretnji donje čeljusti i pri maksimalnoj interkuspidaciji. Iako se autori određenih studija (13, 20) slažu da okluzijske interference rezultiraju promjenama kondilarnog položaja (to je potvrđeno i u ovom istraživanju, tablica 1.), potrebno je istaknuti da su te promjene uzrokovane okluzijskom interferencom potvrđene imedijatnim snimanjem položaja donje čeljusti. Teško je ustanoviti utječu li te promjene i kako na dugotrajni balans temporomandibularnog zgloba, ili kako utječu na moguću progresiju ili nastanak različitih tipova TMD-a.

Suprotno istraživanju Huanga i suradnika (18) koji su tijekom lateralne kretnje s okluzijskom interferencom utvrdili gibanje radnog kondila inferiorno i anteriorno prema kretnji bez interference, u ovom istraživanju ustanovljen je superiorni položaj kondila (tablica 1.). Superiorni položaj kondila (tablica 2.) govori u prilog nastanku poluge na zubnom luku zbog okluzijske interference na jednom zubu (klinička situacija previsokoga protetskog rada ili ispuna).

Zaključak

Unatoč ograničenjima u ovom istraživanju, može se zaključiti da uvođenje okluzijskih interferenca rezultira neposrednim promjenama u položaju mandibularnih kondila u maksimalnoj interkuspidaciji. Utvrđeni superiorni položaj kondila pri okluziji s umjetnom okluzijskom interferencom govori u prilog trenutnog stvaranja poluge na zubnom luku. Nužna su daljnja istraživanja o mogućoj prilagodbi temporomandibularnog zgloba pri nastanku okluzijske interference, posebno kod pacijenata s različitim oblicima temporomandibularnih poremećaja.

Sukob interesa

Nije bilo sukoba interesa.

dibular function has changed with the occurrence of interference (18, 19). Huang et al. (18) investigated the influence of the laterotrusion interferences on the movements of the working condyle. The authors (18) concluded that laterotrusion interferences have a significant immediate influence on the working-side condylar movements. In contrast to the present study, which observed interferences in maximum intercuspation position, Huang et al. (18) investigated the effect of the occlusal interferences on lateral movements. However, with respect to the determined differences (Table 1), the results of Huang et al. (18) study can be interpreted in a fashion similar to the present study. It can be concluded that emergence of the occlusal interferences lead to changes of the condylar position during lateral movements of the lower jaw, and also during maximum intercuspation. Although some authors (13, 20) agreed that occlusal interferences result in changes of condylar position (also confirmed by the results of the present study, see Table 1), it should be emphasized that the changes caused by occlusal interference were confirmed by immediate recording of the lower jaw position. It is difficult to determine how (and whether) these changes affect the long-term balance of the temporomandibular joint, or how (and whether) they affect possible progression or occurrence of different types of the TMD.

Unlike the study carried out by Huang et al. (18), wherein both condylar movements, the inferior and the anterior one, were recorded during the lateral movement of the working condyle with occlusal interference, only the superior condylar position (Table 1) was recorded in the present study. The superior condylar position (Table 1) confirms the occurrence of a lever within dental arches due to the occlusal interference at one tooth (clinically high prosthodontic restoration or dental filling).

Conclusions

Within the limitations of this study it can be concluded that the introduction of occlusal interferences leads to immediate changes of the condylar position in the occlusal position of maximum intercuspation. Determined superior condylar position at occlusion with artificial occlusal interference confirms the immediate lever creation within dental arches. Further research of the temporomandibular joint adaptation upon occurrence of the occlusal interference is necessary, especially in patients with different types of temporomandibular disorders.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Abstract

Aim: The aim of this study was to determine the effect of occlusal interferences on the position of condyles. **Materials and Methods:** The study included 10 participants. All recordings of the condylar position were done using ultrasound jaw tracking device with six degrees of freedom. Paraocclusal tray was fixed in the lower jaw, and the artificial occlusal interference was made on the lower left second premolar with a composite resin, thickness of 1 mm. Condylar shift at the position of the occlusion with the artificial occlusal interference was measured using a jaw tracking device. Condylar positions were determined based on the Cartesian coordinate system. All deviations were measured according to a reference position which was the position of maximum intercuspation. Linear values of deviations between the reference position and the position of the occlusion with the occlusal interference were determined from the values of the Cartesian coordinate system. **Results:** Average superior condylar shift was 0.17 mm, SD 0.39. Average linear deviation between the position of maximum intercuspation and the position of the occlusion with the occlusal interference was 0.48 mm (SD 0.29, min 0.17 mm, max 1.19 mm). **Conclusions:** Occlusal interference leads to immediate change of the condylar position within the temporomandibular joint. Average values of determined superior condylar position confirm occurrence of lever within dental arches. The obtained results must be interpreted within the limitations of this study (immediate measurement of the condylar position). Further research is needed for the analysis of progression of the condylar position with occlusal interferences.

Received: December 27, 2015
Accepted: April 19, 2016

Address for correspondence
Samir Čimić DMD, PhD
University of Zagreb School of Dental Medicine
Department of Prosthodontic
Gundulićeva 5, 10 000 Zagreb
scimic@sfzg.hr

Key words
Dental Occlusion; Mandibular Condyle; Temporomandibular Joint

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