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## Ponovljivost tehnika određivanja centrične relacije s pomoću analize položaja kondila

### *Reproducibility of Centric Relation Techniques by means of Condyle Position Analysis*

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#### Sažetak

**Svrha:** Ovom studijom željela se odrediti ponovljivost kliničkih tehnika centrične relacije (bimanualna manipulacija, vođenje bradom i Rothova metoda) s pomoću analize položaja čeljusnih zglobnih glavica (kondila). **Ispitanici i postupci:** Trideset dva potpuno ozubljena asimptomatska ispitanika (16 žena i 16 muškaraca) s normalnim okluzijskim odnosom (Angleova klasa I) sudjelovala su u ovoj studiji. Njihova prosječna dob bila je  $22,6 \pm 4,7$  godina. Indikator položaja mandibule (MPI) bio je korišten za analizu trodimenzionalnog [anteroposteriorni ( $\Delta X$ ), superoinferiorni ( $\Delta Z$ ), mediolateralni ( $\Delta Y$ )] pomaka kondila čeljusnih zglobova izazvanog razlikom između položaja centrične relacije (CR) i maksimalne interkuspidacije (MI) na razini zubnih lukova. **Rezultati:** Prosječna vrijednost i standardna devijacija trodimenzionalnog pomaka kondila testiranih kliničkih tehnika za određivanje CR-a iznosila je  $0,19 \pm 0,34$  milimetra. Značajne razlike unutar njih zabilježene su za anteroposteriorni pomak kondila na desnoj strani straga ( $\Delta X_{dn/st}$ ;  $P \leq 0,012$ ) i za superoinferiorni pomak na lijevoj strani dolje ( $\Delta Z_{ld}$ ;  $P \leq 0,011$ ); značajne razlike između testiranih tehnika bile su uočene za anteroposteriorni pomak kondila na desnoj strani straga ( $\Delta X_{dn/st}$ ;  $P \leq 0,037$ ), superoinferiorni pomak kondila na desnoj strani dolje ( $\Delta Z_{dd}$ ;  $P \leq 0,004$ ), na lijevoj strani dolje ( $\Delta Z_{ld}$ ;  $P \leq 0,005$ ) i na lijevoj strani gore ( $\Delta Z_{lg}$ ;  $P \leq 0,007$ ). **Zaključak:** Bimanualna manipulacija, vođenje bradom i Rothova metoda kliničke su tehnike za određivanje CR-a jednake točnosti i ponovljivosti kod asimptomatskih ispitanika s normalnim okluzijskim odnosom.

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#### Ključne riječi

zubna okluzija; centrična relacija; mandibularni kondil; bimanualna manipulacija; vođenje bradom; Rothova metoda; indikator položaja mandibule

#### Uvod

Centrična relacija, koliko je proturječna u znanstvenoj literaturi, toliko je neizbježna u svakodnevnoj praksi. Glossary of Prosthodontics Terms (1) definira CR kao odnos gornje i donje čeljusti u kojemu zglobove glavice artikuliraju s najtanjim avaskularnim dijelom njihovih zglobnih pločica, zajedno, u anterosuperiornom položaju spram kosina zglobove kvržice. Ovaj položaj ne ovisi o položaju zuba. Položaj se može klinički odrediti kada se mandibula vodi prema gore i naprijed. Ograničen je na čisto rotacijsku kretanju oko transverzalne šarnirske osi.

Određivanje i ponovljivost stabilnog položaja CR-a kondila čeljusnih zglobova u rekonstrukciji okluzije, odnosno žvačnog sustava, iznimno su važni. Raspon prilagodljivosti unutar žvačnog sustava omogućuje da se u liječenju primijene načela strukture i funkcije. Prema gnatološkom konceptu, određena okluzijska shema u definiranim anatomske granicama dopustit će da se čeljusni zglobovi prilagode i udobno

#### Introduction

Although the review of the scientific literature demonstrated that there are numerous disputes on centric relation (CR) reliability, it is still routinely performed on regular basis in dental clinics. Glossary of Prosthodontics Terms (1) defines centric relation (CR) as "the maxillo-mandibular relationship in which the condyles articulate with the thinnest avascular portion of their respective discs with the complex in the anterior-superior position against the slopes of the articular eminences". This position is independent of tooth contact. In addition, it is clinically visible when the mandible is directed superiorly and anteriorly. Centric relation is restricted to a purely rotary movement about the transverse horizontal axis". Recording and reproducibility of a stable CR position at condyle level play an important role in reconstruction of occlusion and masticatory system. The adaptive capacity of masticatory system allows utilization of structural and functional principles in treatment. According to the traditional

funkcioniraju unutar okluzije (2 – 5). Načela funkcijske okluzije temelje se na morfološkim varijacijama čeljusnih zglobova i Posseltovu dijagramu graničnih kretnji donje čeljusti, što upućuje na to da su strukture žvačnog sustava definirane njegovim dinamičkim biološkim kapacitetom (5 – 8). U osnovi, može se reći da suvremena definicija CR-a balansira između gnatološkog koncepta i koncepta funkcijske okluzije, a da zbog nedostatka uvjerljivih znanstvenih dokaza početni položaj kondila (CR) u razvoju okluzijske sheme za pacijenta ostaje donekle nejasan (9).

Glavno svojstvo CR-a jest da je to razmjerno ponovljiv položaj i u slučaju zdravih i bolesnih čeljusnih zglobova i žvačnih mišića te pri različitom obliku ozubljenosti (potpuna ozubljenost, djelomična i potpuna bezubost). Metode vođenja donje čeljusti mogu se podijeliti na one koje izvodi pacijent (aktivne) i one koje obavlja stomatolog (pasivne) (10, 11). Općenito, vođenje donje čeljusti u CR-u mora se provesti fiziološki pouzdano i nenasilno, jer forsiranje donje čeljusti ne dovodi kondile u centričan položaj. Mnogobrojne su pasivne metode određivanja CR-a (vođenje donje čeljusti obavlja stomatolog), poput metode vođenja brade, troprste metode, Rothove metode, metode bimanualne manipulacije, metode prednjega vođenja s pomoću *Lucia jiga* ili *Pankey jiga*, *the best-bite* naprave, drvene špatule, listića, prednjega zagriznog držača, prednjega deprogramatora, naprave NTI (nociceptivna trigeminalna inhibicija) itd. (6, 12 – 19). Njihovi zagovornici kritiziraju aktivne metode ili metode nevođenja (pacijenti sami dovode zglobove glave u CR) jer smatraju da položaj maksimalne interkuspidacije (MI) nužno ne znači pozicioniranje kondila u centričan i simetričan položaj u zglobnim jamicama. S druge strane, ako postoji mišićni disbalans (npr. bolovi u žvačnim mišićima) koji je uzrokovan preranim okluzijskim kontaktima, također se ne osigurava ponovljiv i provjerljiv položaj CR-a.

Svrha ovog istraživanja bila je utvrditi podudarnost i ponovljivost kliničkog određivanja položaja CR-a koji se rutinski provode u sklopu dijagnostičko-terapijskih protetičkih i ortodontskih postupaka. Korištene su tri metode kliničkog određivanja CR-a – bimanualna manipulacija (Dawsonov hvat), vođenje bradom i Rothova metoda (*power centric*). Odabrane su zato što se najčešće koriste u kliničkom radu, a obrađene su i u mnogim znanstvenim studijama. Na odabranom uzorku istraživanja utvrdit će se prosječne vrijednosti trodimenzionalnog pomaka kondila [mediolateralni ( $\Delta Y$ ), anteroposteriorni ( $\Delta X$ ) i superoinferiorni ( $\Delta Z$ )] na razini gornjega i donjega zubnog luka izazvanog razlikom između položaja CR-a i MI-a. Promatrat će se i spolne razlike s obzirom na navedene varijable. Ispitivanja tijekom studije omogućit će testiranje ponovljivosti i pouzdanosti (unutar i između) metoda određivanja CR-a analizom pomaka kondila čeljusnih zglobova. Nulla hipoteza istraživanja bila je da ne postoji razlika između triju različitih kliničkih tehnika određivanja CR-a.

gnathological principles, certain occlusal scheme, within defined anatomical limitations, permits condyles to adjust and function properly within the occlusal design (2-5). On the other hand, functional occlusion concepts are based on morphological variations in condyle anatomy and Posselt's envelope stating that subunits of masticatory system are controlled by their dynamic biological capacity (5-8). In other words, the modern definition of CR balances between gnathological and functional occlusal theories. It can be concluded that occlusal concept for CR position remains unclear due to the lack of relevant clinical evidence (9).

The main characteristic of CR is its applicability in both healthy and unhealthy temporomandibular joints and masticatory muscles, as well as various dental statuses (dentate, partially dentate, edentulous patients). Mandibular guidance techniques are divided into active (performed by the patient) and passive (performed by the dentist) (10, 11). Generally, a guidance of the mandible into the CR position should be performed in physiologically reliable and unforced manner because an extensive guidance prevents positioning of the condyles in the CR position. There are many passive techniques (6, 12-19) which are used to determine the CR position. They include chin point guidance technique, three-digit technique, Roth's method, bimanual manipulation, anterior guidance technique using Lucia or the Pankey jig, spatula technique, the methods that employ "the best-bite" devices, leaf gauge, anterior deprogrammer, nociceptive trigeminal inhibition device etc. Those who advocate the abovementioned techniques criticize "active or non-guidance techniques" because they believe that the maximum intercuspidation position does not place condyles centrally and symmetrically in the glenoid fossa. On the other hand, the evidence of muscle imbalance (for example, painful masticatory muscles) caused by occlusal premature contacts does not ensure a reproducible and reliable CR position either.

The aim of the study was to determine the consistency and reproducibility of clinically determined CR positions that are routinely performed on prosthetic and orthodontic patients for diagnostic and therapeutic procedures. The following three clinical CR registration techniques were tested: bimanual manipulation (Dawson's grasp), chin point guidance and Roth's method ("power centric"). The above mentioned techniques are frequently used in clinical practice. Also, there is considerable discussion on these techniques in the scientific world. The research was conducted in order to determine the mean values of the three-dimensional condylar shift (mediolateral ( $\Delta Y$ ), anteroposterior ( $\Delta X$ ) and superoinferior ( $\Delta Z$ )) generated by the difference between CR and MI positions at the level of dental arches by using the mandibular position indicator (MPI) (Figure 1). The difference between genders was also investigated considering the examined variables. The design of the study allowed for determination of reproducibility and reliability *within* and *between* CR registration techniques by means of temporomandibular joint condyle shift analysis. The null hypothesis was that there is no difference between the three different clinical CR techniques.

## Materijal i metode

U istraživanju su sudjelovala 32 potpuno ozubljena ispitanika (16 žena i 16 muškaraca) koji su, s obzirom na odnos između donjega i gornjega zubnog luka, imali normalnu okluziju (Angleova klasa I). Svi sudionici potpisali su informirani pristanak, a bili su u dobi od 20 do 33 godine (žene  $22,3 \pm 4,1$ ; muškarci  $22,9 \pm 5,3$ ). Zdravlje im je općenito bilo dobro, u anamnezi nisu imali kliničke znakove i simptome temporomandibularnih poremećaja, parafunkcijske navike, bolesti vratne kralježnice i ortodontske anomalije, te nisu nosili protetičke nadomjestke i ortodontske naprave. Na svakom ispitaniku provedena su četiri mjerenja (prvi dan, sutradan, za tjedan dana i za mjesec dana) za svaku od odabranih kliničkih metoda određivanja centrične relacije. Dakle, ukupno 384 mjerenja.

Analiza pomaka kondila donje čeljusti obavljala se instrumentom, tzv. indikatorom položaja mandibule [Mandibular Position Indicator (MPI), SAM Prazisionstechnik GmbH, Munchen, Njemačka] (slika 1.) (20). Ovaj modularni instrument sastoji se od modificiranoga gornjeg dijela – SAM artikulatora, tj. na mjestu kondilnih kućišta na unutarnjoj osovini gornjega dijela SAM artikulatora nalaze se mjerne kocke, a između je mjerac. Mjerne kocke i mjerac služe za bilježenje trodimenzionalnog prostornog pomaka kondila mandibule [mediolateralni ( $\Delta X$ ), anteroposteriorni ( $\Delta Y$ ) i su-

## Material and methods

32 fully dentate subjects (16 female and 16 male) with normal relations (Angle class I) participated in the study. All the participants signed an informed consent. The subjects ranged from 20 to 33 years of age (female  $22.3 \pm 4.1$ ; male  $22.9 \pm 5.3$ ). The subjects were all in good health and had no past history of any serious illness. They did not have any clinical signs or symptoms of temporomandibular disorder. Also, they were free of parafunctional habits, cervical spine disorders, and orthodontic abnormalities. They had never undergone prosthetic and/or orthodontic therapy. Each CR recording technique was performed four times per subject (at baseline, the following day, 1 week after and 1 month after at approximately the same time of the day), which resulted in a total of 384 measurements.

Mandibular Position Indicator (MPI, SAM Prazisionstechnik GmbH, Muenchen, Germany) was used to analyze the mandibular condylar shift (20). This modular device comprises of a modified upper part of the SAM articulator. It is characterized by sliding cubes positioned on the inner axis of the upper part of the SAM articulator in place of condyle housings and a gauge placed in between. Sliding cubes and the gauge recorded a three-dimensional spatial shift (mediolateral ( $\Delta X$ ), anteroposterior ( $\Delta Y$ ), superoinferior ( $\Delta Z$ )) in millimeters between the CR and the MI position relative



Slika 1. Indikator položaja mandibule (MPI)  
Figure 1 Mandibular Position Indicator (MPI).

peroinferiorni ( $\Delta Z$ )] u odnosu na definirane mjerne točke na šarnirskoj osi i incizalnom kolčiću. Desni i lijevi anteroposteriorni i superoinferiorni pomaci bili su mjereni na mjernim kockama, a bilateralni mediolateralni pomaci ( $\Delta Y$  desno,  $\Delta Y$  lijevo) bili su prikazani na analognom mjeracu. Bili su zabilježeni pomaci osi anteroposteriorno ( $\Delta X$  desno sprijeda,  $\Delta X$  desno straga,  $\Delta X$  lijevo sprijeda,  $\Delta X$  lijevo straga) i superoinferiorno ( $\Delta Z$  desno dolje,  $\Delta Z$  desno gore,  $\Delta Z$  lijevo dolje,  $\Delta Z$  lijevo gore) između položaja CR-a i MI-ja.

Svakom ispitaniku uzet je anatomski otisak zubnih lukova (Aroma fine plus, GC Corporation, Japan) iz kojih su izrađeni radni modeli od tvrde sadre (Alpenrock tip IV, Amann Girrbach, Austrija).

to the predefined hinge axis position on the sliding cubes and the initial position of the incisal pin. Right and left anteroposterior and superoinferior shifts were measured on the sliding cubes, whereas bilateral mediolateral shifts ( $\Delta Y$  right,  $\Delta Y$  left) were displayed on the analog dial of the gauge. Displacements of the axis in the anteroposterior ( $\Delta X$  right anterior,  $\Delta X$  right posterior,  $\Delta X$  left inferior,  $\Delta X$  left superior) and superoinferior ( $\Delta Z$  right anterior,  $\Delta Z$  right posterior,  $\Delta Z$  left inferior,  $\Delta Z$  left superior) direction between CR and MI were registered.

Master casts made from hard dental stone plaster (Alpenrock type IV, Amann Girrbach, Austria) were fabricated upon the anatomical alginate impressions (Aroma fine plus,

Na radnim modelima pripremljen je odgovarajući centrični registrat, ovisno o zahtjevima odabranih kliničkih metoda za određivanje položaja centrične relacije. Dijagnostička valjanost analize položaja kondila ovisi o kvaliteti centričnog registrata. Centrični registrat mora biti kvalitetan i izrađen od tvrdog materijala. Za njegovu bazu upotrijebljen je tvrdi vosak (Beauty Pink, Moyco Industries, SAD) i aluminijski vosak (Aluwax, Aluwax Dental Products, SAD) za bilježenje impresija donjih zuba u trima točkama (prednji, desni i lijevi postranični segment). Prije postupka registracije CR-a ispitanik se deprogramirao grizući vaterolicu između prednjih zuba oko pet minuta. Deprogramiranjem se postiže stabilizacija donje čeljusti tijekom registracije CR-a i poništava proprioceptivni učinak iz zuba i žvačnih mišića (10, 21, 22).

Istraživanje je odobrilo Etičko povjerenstvo Stomatološkog fakulteta Sveučilišta u Zagrebu, Hrvatska.

## Rezultati

Svi podaci bili su pohranjeni u bazi podataka (Microsoft Office Excel 2010) i daljnja statistička raščlamba provedena je licenciranim statističkim paketom SPSS 12.0 za Windows.

U tablici 1. nalaze se deskriptivna obilježja (srednje vrijednosti i standardne devijacije) obostranog trodimenzionalnog pomaka kondila [mediolateralni ( $\Delta Y$ ), anteroposteriorni ( $\Delta X$ ) i superoinferiorni ( $\Delta Z$ )] izmjenjenog za sve tri testirane kliničke metode određivanja CR-a (bimanualna manipulacija, vođenje bradom i *power centrik*).

Vrijednost trodimenzionalnih pomaka iznosila je u prosjeku  $0,19 \pm 0,34$  milimetra (asimptomatski ispitanici s Angleovom klasom I). Nije zabilježena statistički značajna razlika ( $p \geq 0,05$ ) između spolova za izmjerene obostrane trodimenzionalne pomake (Mann-Whitneyev test, tablica 2.).

Neparametrijskim Kruskal-Wallisovim testom ispitane su razlike unutar i između kliničkih metoda određivanja CR-a (bimanualna manipulacija, vođenje bradom i *power centrik*) na temelju izmjerenih obostranih trodimenzionalnih pomaka kondila. U tablici 3. zabilježene su statistički značajne razlike unutar testiranih kliničkih metoda određivanja centrične relacije za anteroposteriorni pomak kondila na desnoj strani

GC Corporation, Japan) of dental arches for each subject involved in the study. According to the CR registration, a record was prepared on each master cast depending on the clinical CR recording technique requirements. The quality of CR registration records greatly influences the diagnostic validity of the condyle position analysis. Bite records should be made of rigid material. They should be of high quality. The base layer of the CR bite record was made of hard wax (Beauty Pink, Moyco Industries, USA). Softer wax (Aluwax, Aluwax Dental Products, USA) was used to record impressions of mandibular teeth in three points (anterior, right and left lateral segment). Each subject was first "deprogrammed" by biting into a cotton pellet (jig) between the anterior teeth for 5 minutes in order to stabilize the mandible during CR recording and delete the proprioceptive perception received from teeth and masticatory muscles (10, 21, 22).

The study was approved by the Ethics Committee of the School of Dental Medicine, University of Zagreb, Croatia.

## Results

The data were saved to the database (Microsoft Office Excel 2010) and a statistical analysis using a licenced software package SPSS 12.0. for Windows was performed.

Table 1 shows descriptive characteristics (mean values and standard deviations) of bilateral three-dimensional condylar shifts (mediolateral ( $\Delta Y$ ), anteroposterior ( $\Delta X$ ) and superoinferior ( $\Delta Z$ )) for the following three clinical CR registration techniques (bimanual manipulation, chin point guidance and Roth's method).

The value of the three-dimensional shifts averaged  $0.19 \pm 0.34$  mm (asymptomatic subjects with an Angle class I). No statistically significant difference ( $p \geq 0.05$ ) for bilateral three-dimensional shifts between genders was found (Mann-Whitney test, Table 2).

A non-parametric Kruskal-Wallis test was used to observe differences in bilateral three-dimensional shifts *within* and *between* the different clinical CR recording techniques. Table 3 of this paper shows statistically significant differences *within* the tested clinical CR registration techniques for anteroposterior condylar shift on the right side posterior ( $\Delta X_{rp}$ ;  $P \leq 0.012$ ) and superoinferior condylar shift on the left side inferior ( $\Delta Z_{li}$ ;  $P \leq 0.011$ ). The same trend can be noticed

**Tablica 1.** Deskriptivna obilježja obostranog trodimenzionalnog pomaka kondila između CR-a i MI-ja za testirane kliničke tehnike određivanja CR-a

**Table 1** Descriptive characteristics of bilateral three-dimensional condylar shifts between CR and MI for tested clinical CR registration techniques.

	$\Delta Y_d \bullet$ $\Delta Y_r$	$\Delta Y_l$	$\Delta X_{ds} \bullet$ $\Delta X_{ra}$	$\Delta X_{dst} \bullet$ $\Delta X_{rp}$	$\Delta Z_{dd} \bullet$ $\Delta Z_{ri}$	$\Delta Z_{dg} \bullet$ $\Delta Z_{rs}$	$\Delta X_{ls} \bullet$ $\Delta x_{la}$	$\Delta X_{lst} \bullet$ $\Delta X_{lp}$	$\Delta Z_{ld} \bullet$ $\Delta Z_{li}$	$\Delta Z_{lg} \bullet$ $\Delta Z_{ls}$	$U \bullet$ Tot
N	384	384	384	384	384	384	384	384	384	384	384
x	0.19	0.14	0.15	0.28	0.18	0.18	0.25	0.18	0.18	0.18	0.19
SD	0.23	0.25	0.29	0.49	0.32	0.34	0.34	0.43	0.33	0.33	0.34

$\Delta Y_d$  – mediolateralni pomak desno;  $\Delta Y_l$  – mediolateralni pomak lijevo;  $\Delta X_{ds}$  – anteroposteriorni pomak desno sprijeda;  $\Delta X_{dn/st}$  – anteroposteriorni pomak desno straga;  $\Delta Z_{dd}$  – superoinferiorni pomak desno dolje;  $\Delta Z_{dg}$  – superoinferiorni pomak desno gore;  $\Delta X_{ls}$  – anteroposteriorni pomak lijevo sprijeda;  $\Delta X_{ln/st}$  – anteroposteriorni pomak lijevo straga;  $\Delta Z_{ld}$  – superoinferiorni pomak lijevo dolje;  $\Delta Z_{ls}$  – superoinferiorni pomak lijevo gore;  $U$  – ukupno

$\Delta Y_r$  – mediolateral shift to the right;  $\Delta Y_l$  – mediolateral shift to the left;  $\Delta X_{ra}$  – anteroposterior shift right anterior;  $\Delta X_{rp}$  – anteroposterior shift right posterior;  $\Delta Z_{ri}$  – superoinferior shift right inferior;  $\Delta Z_{rs}$  – superoinferior shift right superior;  $\Delta X_{la}$  – anteroposterior shift left anterior;  $\Delta X_{lp}$  – anteroposterior shift left posterior;  $\Delta Z_{li}$  – superoinferior shift left inferior;  $\Delta Z_{ls}$  – superoinferior shift left superior; Tot - Total.



**Tablica 2.** Vrijednosti Mann-Whitneyjeva testa za obostrane trodimenzionalne pomake kondila s obzirom na spol  
**Table 2** Mann-Whitney test values for bilateral three-dimensional condylar shift variables with respect to gender.

	Mann-Whitney U	Wilcoxon W	Z	Značajnost • Significance
$\Delta Yd \cdot \Delta Yr$	17513	36549	-0.89	0.372
$\Delta Yl$	17053	35581	-1.49	0.135
$\Delta Xds \cdot \Delta Xra$	17453	35981	-1.18	0.236
$\Delta Xdn/st \cdot \Delta Xrp$	17588	36116	-0.95	0.343
$\Delta Zdd \cdot \Delta Zri$	18344	36872	-0.10	0.918
$\Delta Zdg \cdot \Delta Zrs$	16596	35124	-2.17	0.03
$\Delta Xls \cdot \Delta Xla$	17587	36115	-0.89	0.373
$\Delta Xln/st \cdot \Delta Xlp$	18363	36891	-0.09	0.929
$\Delta Zld \cdot \Delta Zli$	17745	36273	-0.80	0.423
$\Delta Zlg \cdot \Delta Zls$	17835	36363	-0.69	0.486

$\Delta Yd$  – mediolateralni pomak desno;  $\Delta Yl$  – mediolateralni pomak lijevo;  $\Delta Xds$  – anteroposteriorni pomak desno sprijeda;  $\Delta Xdn/st$  – anteroposteriorni pomak desno straga;  $\Delta Zdd$  – superoinferiorni pomak desno dolje;  $\Delta Zdg$  – superoinferiorni pomak desno gore;  $\Delta Xls$  – anteroposteriorni pomak lijevo sprijeda;  $\Delta Xln/st$  – anteroposteriorni pomak lijevo straga;  $\Delta Zld$  – superoinferiorni pomak lijevo dolje;  $\Delta Zls$  – superoinferiorni pomak lijevo gore  
 $\Delta Yr$  – mediolateral shift to the right;  $\Delta Yl$  – mediolateral shift to the left;  $\Delta Xra$  – anteroposterior shift right anterior;  $\Delta Xrp$  – anteroposterior shift right posterior;  $\Delta Zri$  – superoinferior shift right inferior;  $\Delta Zrs$  – superoinferior shift right superior;  $\Delta Xla$  – anteroposterior shift left anterior;  $\Delta Xlp$  – anteroposterior shift left posterior;  $\Delta Zli$  – superoinferior shift left inferior;  $\Delta Zls$  – superoinferior shift left superior.

**Tablica 3.** Kruskal-Wallisov test korišten u procjeni tehnika određivanja CR-a (bimanualna manipulacija, vođenje bradom i Rothova metoda) unutar metoda

**Table 3** Kruskal-Wallis test used in evaluation of CR registration techniques (bimanual manipulation, chin point guidance and Roth's method) within methods.

	Hi-kvadrat • Hi-square	Df	Značajnost • Significance
$\Delta Yd \cdot \Delta Yr$	3.770	3	0.287
$\Delta Yl$	3.051	3	0.384
$\Delta Xds \cdot \Delta Xra$	1.775	3	0.620
$\Delta Xdn/st \cdot \Delta Xrp$	11.005	3	0.012
$\Delta Zdd \cdot \Delta Zri$	3.848	3	0.278
$\Delta Zdg \cdot \Delta Zrs$	1.069	3	0.785
$\Delta Xls \cdot \Delta Xla$	2.074	3	0.557
$\Delta Xln/st \cdot \Delta Xlp$	0.984	3	0.805
$\Delta Zld \cdot \Delta Zli$	11.068	3	0.011
$\Delta Zlg \cdot \Delta Zls$	3.896	3	0.273

$\Delta Yd$  – mediolateralni pomak desno;  $\Delta Yl$  – mediolateralni pomak lijevo;  $\Delta Xds$  – anteroposteriorni pomak desno sprijeda;  $\Delta Xdn/st$  – anteroposteriorni pomak desno straga;  $\Delta Zdd$  – superoinferiorni pomak desno dolje;  $\Delta Zdg$  – superoinferiorni pomak desno gore;  $\Delta Xls$  – anteroposteriorni pomak lijevo sprijeda;  $\Delta Xln/st$  – anteroposteriorni pomak lijevo straga;  $\Delta Zld$  – superoinferiorni pomak lijevo dolje;  $\Delta Zls$  – superoinferiorni pomak lijevo gore; Df – stupnjevi slobode

$\Delta Yr$  – mediolateral shift to the right;  $\Delta Yl$  – mediolateral shift to the left;  $\Delta Xra$  – anteroposterior shift right anterior;  $\Delta Xrp$  – anteroposterior shift right posterior;  $\Delta Zri$  – superoinferior shift right inferior;  $\Delta Zrs$  – superoinferior shift right superior;  $\Delta Xla$  – anteroposterior shift left anterior;  $\Delta Xlp$  – anteroposterior shift left posterior;  $\Delta Zli$  – superoinferior shift left inferior;  $\Delta Zls$  – superoinferior shift left superior; df – degrees of freedom.

straga ( $\Delta Xdn/st$ ;  $P \leq 0,012$ ) i superoinferiorni pomak kondila na lijevoj strani dolje ( $\Delta Zld$ ;  $P \leq 0,011$ ). Isti trend vidi se u tablici 4. gdje su, između testiranih metoda, statistički značajne razlike registracije CR-a zabilježene za anteroposteriorni pomak kondila desno straga ( $\Delta Xdn/st$ ,  $P \leq 0,037$ ) i superoinferiorni pomak desno dolje ( $\Delta Zdd$ ,  $P \leq 0,004$ ), lijevo dolje ( $\Delta Zld$ ,  $P \leq 0,005$ ) i lijevo gore ( $\Delta Zlg$ ,  $P \leq 0,007$ ). Ove razlike mogu se objasniti kao rezultat odstupanja (anomalija) tijekom obavljanja mjerenja, prije negoli tendencijom da unutar i između testiranih metoda određivanja CR-a postoji nekonzistentnost.

in Table 4 with statistically significant differences in anteroposterior shift on the right side posterior ( $\Delta Xrp$ ,  $P \leq 0.037$ ) and superoinferior shift on the right side inferior ( $\Delta Zri$ ,  $P \leq 0.004$ ), on the left side inferior ( $\Delta Zli$ ,  $P \leq 0.005$ ) and on the left side superior ( $\Delta Zls$ ,  $P \leq 0.007$ ) between the tested CR registration techniques. The differences can be explained as aberration (anomaly) in results obtained during measuring rather than the tendency towards inconsistencies within and between CR registration techniques.

**Tablica 4.** Kruskal-Wallisov test korišten u procjeni tehnika određivanja CR-a (bimanualna manipulacija, vođenje bradom i Rothova metoda) između metoda  
**Table 4** Kruskal-Wallis test used in evaluation of CR registration techniques (bimanual manipulation, chin point guidance and Roth's method) between methods.

	Hi-kvadrat • Hi-square	Df	Značajnost • Significance
$\Delta Yd \bullet \Delta Yr$	0.263	2	0.877
$\Delta Yl$	0.593	2	0.744
$\Delta Xds \bullet \Delta Xra$	5.180	2	0.075
$\Delta Xdn/st \bullet \Delta Xrp$	6.580	2	0.037
$\Delta Zdd \bullet \Delta Zri$	11.284	2	0.004
$\Delta Zdg \bullet \Delta Zrs$	2.409	2	0.300
$\Delta Xls \bullet \Delta Xla$	0.762	2	0.683
$\Delta Xln/st \bullet \Delta Xlp$	1.153	2	0.562
$\Delta Zld \bullet \Delta Zli$	10.574	2	0.005
$\Delta Zlg \bullet \Delta Zls$	9.857	2	0.007

$\Delta Yd$  – mediolateralni pomak desno;  $\Delta Yl$  – mediolateralni pomak lijevo;  $\Delta Xds$  – anteroposteriorni pomak desno sprijeda;  $\Delta Xdn/st$  – anteroposteriorni pomak desno straga;  $\Delta Zdd$  – superoinferiorni pomak desno dolje;  $\Delta Zdg$  – superoinferiorni pomak desno gore;  $\Delta Xls$  – anteroposteriorni pomak lijevo sprijeda;  $\Delta Xln/st$  – anteroposteriorni pomak lijevo straga;  $\Delta Zld$  – superoinferiorni pomak lijevo dolje;  $\Delta Zls$  – superoinferiorni pomak lijevo gore;  $Df$  – stupnjevi slobode

$\Delta Yr$  – mediolateral shift to the right;  $\Delta Yl$  – mediolateral shift to the left;  $\Delta Xra$  – anteroposterior shift right anterior;  $\Delta Xrp$  – anteroposterior shift right posterior;  $\Delta Zri$  – superoinferior shift right inferior;  $\Delta Zrs$  – superoinferior shift right superior;  $\Delta Xla$  – anteroposterior shift left anterior;  $\Delta Xlp$  – anteroposterior shift left posterior;  $\Delta Zli$  – superoinferior shift left inferior;  $\Delta Zls$  – superoinferior shift left superior;  $df$  – degrees of freedom

## Rasprava

U znanstvenoj literaturi spominju se različite metode određivanja CR-a. Procjena njihove pouzdanosti iznimno je važna u kliničkom radu jer pokazuje koja je najtočnija te stoga i najprihvatljivija za stomatologa i pacijenta. U ovom istraživanju sve tri testirane metode određivanja relacije (bimanualna manipulacija, vođenje bradom i *power centrik*) pokazale su veliku pouzdanost i ponovljivost tijekom mjerenja trodimenzionaloga pomaka kondila s obzirom na odabrani uzorak (mlađi ispitanici s normalnom okluzijom i zdravim čeljusnim zglobovima) i svrhu studije te dobivene prosječne vrijednosti trodimenzionalnoga pomaka kondila. Mnogobrojni su znanstveni radovi o ovoj temi, no usporedba s tim ispitivanjima može nas odvesti u pogrešnom smjeru jer svaka studija ima svoj dizajn, odabir ispitanika i statističke metode. Studije u kojima se testirala samo jedna tehnika (npr. bimanualna manipulacija, tehnika gotskog luka, vođenje bradom, *push-back* tehnika, neuromišićni centrik, Rothova metoda i druge) određivanja CR-a različitim metodologijama (ne samo indikatorom pomaka mandibule, nego aksiografijom, uređajem *Arcus digma*, radiografskim tehnikama (kompjutorizirana tomografija, magnetska rezonancija) uglavnom pokazuju da su tehnike bile ponovljive i pouzdane kod simptomatskih i asimptomatskih ispitanika (9,19,21,23-28). Ipak, prevladavaju studije u kojima se provjeravala konzistentnost dviju ili triju metoda određivanja CR-a. Swenson i suradnici (29-31) ispitivali su pomake položaja kondila na temelju pet metoda određivanja CR-a (Rothova metoda, vrh jezika na meko nepce, vođenje brade, bimanualna manipulacija i mjerne listiće) i zaključili da su sve bile ponovljive jer su zabilježeni mali rasponi pomaka položaja kondila. Keshvad i Winstanley (32) proveli su sličnu studiju koja je prema svrsi i metodologiji najbliža ovom istraživanju, no koristili su se tehnikom gotskog luka umjesto *power centrika*. Uočeno je da su bimanualna manipulacija i vođenje bradom ponovljiviji od

## Discussion

Different CR recording techniques have been described in the literature. The reliability evaluation of these techniques is extremely important in clinical practice in order to determine the most accurate and most accepted technique by both the dentist and patients. All methods of CR registration (bimanual manipulation, chin point guidance and Roth's method) tested in this study revealed a high reliability and reproducibility in accordance with the three-dimensional condylar shift measurements. The recorded results were expected due to the tested sample (young population with normal occlusal relations and healthy TMJ), the design of the study and mean values of three-dimensional condylar shifts. Although many scientific papers address the very same subject, a comparison between them should not be drawn since there is a difference in design in each study. Besides, different inclusion criteria are applied and different statistical analyses are performed. The studies (9,19,21,23-28) in which only one CR registration technique was used (bimanual manipulation, Gothic arch tracing, chin point guidance, push-back technique, neuromuscular centric technique, Roth's technique and others) using different methodologies (not only mandible position indicator, but also axiography, Arcus digma diagnostics, radiographic techniques (computerized tomography, magnetic resonance)) mostly concluded that all the techniques were reproducible and reliable in both symptomatic and asymptomatic examinees. In the scientific literature, there are also studies (29-31) that examined the consistency of two or more CR recording techniques.

Swenson et al. (29) examined the condylar positions generated by the five CR registration techniques (Roth power centric bite, tongue tip to soft palate, chin point guidance, bimanual manipulation and leaf gauge) and concluded that all methods of CR registration resulted in a very small range of condylar positions. Keshvad and Winstanley (32) conduct-

tehnike gotskoga luka koja se pokazala najmanje konzistentnom. Rezultati dobiveni u spomenutoj studiji bili su u skladu s našim rezultatima. No naša studija pokazuje istu točnost za sve tri analizirane tehnike. Velika podudarnost može biti rezultat bolje pripreme (deprogramiranja) ispitanika prije uzimanja centričnog registrata. U mnogobrojnim znanstvenim studijama (21, 26, 29, 30 – 33) prevladava zaključak da je bimanualna manipulacija s prednjim deprogramatorom najpouzdanija i najponovljivija metoda u određivanju zglobnog položaja CR-a. No nisu rijetke ni one sa suprotnim predznakom, poput metode Paixão i suradnika (37). Njihovi rezultati pokazuju da je metoda gotskoga luka ponovljivija od metode bimanualne manipulacije. Istraživanja u kojima se o CR-u govori kao o referentnom, ali ne i fiziološkom položaju, u novijoj studiji pokušavaju opovrgnuti Venturelli i suradnici (38). Oni su promatrali pomake kondila čeljusnoga zgloba asimptomatskih ispitanika s pomoću magnetske rezonancije, transkranijalne radiografije i analize terminalne šarnirske osi u artikulatu i na njihovu su okluziju dodatno djelovali nagriznom pločom i *Lucia jigom*. Novonastali pomaci uzrokovani djelovanjem nagrizne ploče i deprogramatora na kraju nisu prouzročili statistički značajne pomake kondila na razini čeljusnih zglobova, u odnosu na početno stanje. Time je potvrđen adaptabilni kapacitet čeljusnoga zgloba i njegovo svojstvo da održi taj položaj u fiziološkim granicama, bez obzira na iatrogene čimbenike iz okoliša.

Ideja za ovo istraživanje bila je potaknuta činjenicom da se CR upotrebljava kao entitet u nastavnim i praktičkom kurikulumu prijediplomske i poslijediplomske edukacije te da se, nakon završetka toga razdoblja, uočava nedostatak znanja. No nepoznavanje gradiva ne muči samo studente, nego je to širi problem u pojedinim specijalizacijama u sklopu stomatološke struke (39). To najbolje pokazuju studije koje se bave ispitivanjem podudarnosti u programima stomatoloških fakulteta (40), zatim podudaranjem onoga što prezentiraju nastavnici kada govore o CR-u ili postoji li konsenzus među različitim specijalizacijama koje se CR-om koriste u kliničkom radu (npr. protetičari, maksilofacijalni kirurzi i ortodonti) (41). Nažalost, rezultati ovih studija pokazuju neslaganje i nepodudaranje unutar i između metoda. Prema svemu sudeći, na području CR-a trebat će provesti daljnja znanstvena istraživanja (ako je moguće randomizirana) kako bi se jednog dana stabilizirali definicija, položaj i primjena ovoga spornog položaja.

## Zaključci

Unutar ograničenja ovog istraživanja može se zaključiti sljedeće: prosječna vrijednost trodimenzionalnog pomaka kondila testiranih CR tehnika iznosila je  $0,19 \pm 0,34$  milimetra; ovaj rezultat može se smatrati normalnim ako je riječ o mladim asimptomatskim ispitanicima s Angleovom klasom okluzije I, nisu nađene statistički značajne razlike između spolova ( $p \geq 0,05$ ), pouzdanost i ponovljivost bimanu-

al studiju to ours in terms of design and methodology. Instead of the “power centric” technique, they evaluated Gothic arch tracing. They found that bimanual mandibular manipulation and chin point guidance were more reproducible than Gothic arch tracing, which was least consistent of the three techniques. The results obtained in the mentioned study are somewhat in line with our findings. However, the present study shows the same accuracy for all of the three analyzed techniques. This strong consistency might be the result of a better subject “deprogramming” procedure prior to the CR record registration. Numerous scientific publications (21, 26, 32, 33-36) have pointed out that bimanual mandibular manipulation with anterior deprogrammer is one of the most reliable and reproducible methods of determining CR in dentistry. However, there are also scientific publications that oppose this finding, as the one conducted by Paixão et al (37). Their results showed that a Gothic arch tracing was a more reproducible CR registration technique than bimanual mandibular manipulation. Venturelli et al. tried to dispute the studies in which CR was considered a referent, but not physiological position (38). They observed the temporomandibular joint condyles using magnetic resonance, transcranial radiography and articulator terminal hinge axis analysis in asymptomatic subjects whose occlusion was additionally deprogrammed by occlusal bite and Lucia jig deprogrammers. Those deprogrammers did not cause any statistically significant difference in TMJ condyle shifts regarding their initial position. This contributed to the adaptive capacity of the temporomandibular joint and its capability to maintain the adapted position within physiological boundaries regardless of the environmental and iatrogenic impacts.

The idea for the study came from the fact that the CR is included in both educational and practical curriculum of pre and post-doctoral programs. A lack of relevant knowledge was noticed after the completion of degree programs. Some studies suggest that not only should there be concern over student knowledge of CR but also over some dentist knowledge and certain specialists (39). This is best shown in studies which examined the compatibility of dental curricula within different university study programs (40), as well as presentations on CR given by educators and existence of consensus among different specialists (in prosthodontics, orthodontics and maxillofacial surgery) who use CR in their clinical practice (41). Unfortunately, the results of those studies were in discrepancy and inconsistency *within and between* the tested techniques. Further studies on CR are needed (possibly randomized) in order to find the definition, position and usage of this controversial term.

## Conclusions

Within the limitations of this study, the following conclusions can be drawn: Mean value of the three-dimensional condylar shift of the tested CR techniques was  $0.19 \pm 0.34$  mm. This result could be considered a normal CR finding in young asymptomatic subjects with Angle class I occlusion. No statistically significant difference ( $p \geq 0.05$ ) between genders was found; Reliability and reproducibility of bimanual

alne manipulacije donje čeljusti, vođenja bradom i Rothove metode (*power centric*), kao kliničkim metodama za određivanje položaja CR-a, dokazane su analizom trodimenzionalnog pomaka kondila, nulta hipoteza je prihvaćena – sve tri testirane metode u istraživanju bile su pouzdane i ponovljive te se s istom točnošću mogu primjenjivati u svakodnevnoj kliničkoj praksi.

## Zahvale

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## Sukob interesa

Autori nisu bili u sukobu interesa.

mandibular manipulation, chin point guidance and Roth's method ("power centric"), as clinical methods in CR registration technique determination, is proved by the three-dimensional condylar shift analysis. The null hypothesis was accepted. All three methods that were tested in the study are reliable and consistent and can be performed in daily clinical practice with the same accuracy.

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## Conflict of interest

None declared

### Abstract

**Purpose:** The aim of this study was to determine the reproducibility of clinical centric relation (CR) registration techniques (bimanual manipulation, chin point guidance and Roth's method) by means of condyle position analysis. **Material and methods:** Thirty two fully dentate asymptomatic subjects (16 female and 16 male) with normal occlusal relations (Angle class I) participated in the study (mean age, 22.6 ± 4.7 years). The mandibular position indicator (MPI) was used to analyze the three-dimensional (anteroposterior ( $\Delta X$ ), superoinferior ( $\Delta Z$ ), mediolateral ( $\Delta Y$ )) condylar shift generated by the difference between the centric relation position (CR) and the maximal intercuspation position (MI) observed in dental arches. **Results:** The mean value and standard deviation of three-dimensional condylar shift of the tested clinical CR techniques was 0.19 ± 0.34 mm. Significant differences *within* the tested clinical CR registration techniques were found for anteroposterior condylar shift on the right side posterior ( $\Delta X_{rp}$ ;  $P \leq 0.012$ ); and superoinferior condylar shift on the left side inferior ( $\Delta Z_{li}$ ;  $P \leq 0.011$ ), whereas *between* the tested CR registration techniques were found for anteroposterior shift on the right side posterior ( $\Delta X_{rp}$ ,  $P \leq 0.037$ ) and superoinferior shift on the right side inferior ( $\Delta Z_{ri}$ ,  $P \leq 0.004$ ), on the left side inferior ( $\Delta Z_{li}$ ,  $P \leq 0.005$ ) and on the left side superior ( $\Delta Z_{ls}$ ,  $P \leq 0.007$ ). **Conclusion:** Bimanual manipulation, chin point guidance and Roth's method are clinical CR registration techniques of equal accuracy and reproducibility in asymptomatic subjects with normal occlusal relationship.

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### Key words

Dental Occlusion; Centric Relation; Mandibular Condyle; Bimanual Manipulation; Chin Point Guidance; Roth's Method; Mandibular Position Indicator

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