Study of the Difference Between Centric Occlusion and Retruded Contact Position

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Abstract: Purpose: The aim of this study was to investigate the difference between retruded contact position (RCP) and centric occlusion (CO) at the level of mandibular condyles.

Materials and methods: Study included 20 completely dentate participants (average 24.4 ± 1.2 years). All recordings of the condylar deviations were measured with the use of the ultrasound mandibular recording device with six degrees of freedom. CO was determined using active method of centric relation recording (participants were trained to stationary hinge and maintain the position of the lower jaw at the first tooth contact/contacts). RCP was determined with passive method of centric relation recording (chin point guidance). RCP and CO deviations to the reference position (habitual occlusion) were recorded with the use of the mandibular recording device at the level of x (anterior – posterior), y (vertical) and z (lateral) axes. Linear RCP and CO deviations (from the habitual occlusion) were measured. Descriptive statistics was measured, and the RCP and CO deviation values were compared using independent samples T test.

Results: Average linear condylar deviation values for the CO were 1.30 ± 1.14 mm, and 2.13 ± 1.89 mm for the RCP. Independent samples T test showed statistically significant difference between RCP and CO linear deviation values (α=0.021).

Conclusions: There is a difference in the positioning of the condyle within temporomandibular joint, with passive or active centric relation recording methods. CO and RCP can be identified as different occlusal positions.

Keywords: Centric relation, Prosthodontics, Temporomandibular joint.

INTRODUCTION

Centric relation (CR) is basic maxillomandibular relationship in prosthetic dentistry. It is one of the controversial terms in dental medicine. For many years there have been more than few definitions of the CR, which shows the difficulty of a complete and acceptable definition of the term. There are more than 26 definitions of the CR [1]. "The glossary of prosthodontics terms" from 2005th [2] offers 7 (correct) definitions. According to the last (seventh) definition the CR is the maxillomandibular relationship in which the condyles articulate with the thinnest avascular portion of their respective disks with the complex in the anterior-superior position against the shapes of the articular eminencies. This position is independent of tooth contact. It is restricted to a purely rotary movement about the transverse horizontal axis [2].

Although CR represents condylar position, in scientific and professional literature with the term CR are closely connected terms retruded contact position (RCP) and centric occlusion (CO), which represent occlusion contact/contacts in the CR position. According to "The glossary of prosthodontic terms" [3] CO is the occlusion of opposing teeth when the mandible is in centric relation, while RCP represents guided occlusal relationship occurring at the most retruded position of the condyles in the joint cavities. "The glossary of prosthodontic terms" [3] suggests that the RCP is a position that may be more retruded than the CO.

Most of the studies of the CR position and comparison of the different methods of determining the CR position were done in articulators with condyle position indicator [4-11]. With difference of the casts position to articulator axis and real patients terminal hinge axis, and articulators rigidity, certain differences between articulators condyle to condylar movements in patients are expected. Jaw tracking devices with six degrees of freedom are standardly used for investigation of temporomandibular joint function and morphology [12-15]. Obrez and Gallo [16] stated that only since the development of 3-dimensional recording systems supplemented with sophisticated mathema-

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tical transformation of the obtained data (six degrees of freedom concept) has it been possible to estimate condylar movements relatively accurately.

The purpose of this *in vivo* investigation was to study the difference between the RCP and the CO using jaw tracking device with six degrees of freedom.

MATERIALS AND METHODS

Study included 20 completely dentate participants (beside wisdom teeth) without signs and symptoms of temporomandibular disorders (24.4 ± 1.2 years) and without previous orthodontic treatment. Participants had Angle class I relationship of the first molar teeth, without open bite or crossbite and without previous prosthetic or major restorative treatment. Participants were recruited at Department of Removable Prosthodontics (School of Dental Medicine, University of Zagreb, Croatia), where measurements were also done. They were recruited from incoming patients, and also from students. Exclusion criteria were signs and/or symptoms of temporomandibular disorders, previous orthodontic treatment, other than Angle class I relationship of the first molar teeth, open bite, crossbite and previous prosthetic or major restorative treatment. Before engaging in investigation, every participant had to sign written informed consent, approved by the Ethical committee of the School of Dental Medicine in Zagreb, Croatia.

Measurements were done using ultrasound mandibular recording device for recording of the lower jaw movements (Arcus Digma II, Kavo, Biberach, Germany), which operates with six degrees of freedom principle. Lower bow with ultrasound transmitters is fixed to the lower teeth, while upper bow (facebow) is attached to participants head. The device measures real time latency period between emitted and received ultrasound signals. Based on six degrees of freedom concept, software of the device calculates spatial position of mandibular condyles, sagittal incisal point and/or different occlusal determinants, depending on the used module.

First, irreversible hydrocolloid impressions (Aroma Fine Plus, GC, Tokyo, Japan) of both jaws were taken to each participant and stone casts were poured (ISO type 2, Alabaster, Polident, Slovenia). On the lower jaw cast was made paraocclusal tray using light polymerizing acrylic resin (Unitray, Polident, Volčja Draga, Slovenia), based on manufacturers recommendations. On the next appointment studied positions of mandibular condyles were recorded using ultrasound mandibular recording device with six degrees of freedom. Every participant was seated comfortably in the chair (upright posture). Paraocclusal tray was fixed on the buccal side of the lower teeth using acrylic resin for temporary restoration (Structur, Voco, Cuxhaven, Germany). After fixation of the paraocclusal tray facebow was mounted on the participants head. All measurements were done using "Electronic Position Analysis" of the device (EPA), according to manufacturer's instructions. After mounting of the lower bow and facebow, position of a habitual occlusion was recorded as a reference position. All condylar deviations were measured according to the reference position. First measured position was position of condyles during active recording of the centric relation (CO). Every participant was carefully trained to hinge and retrude lower jaw, and to hold at first tooth contact/contacts, so the position of CO could be recorded. Second measured position was condylar position during passive recording of the centric relation (RCP). With operators chin point guidance was determined CR and position of condyles was recorded. Within devices software ("Kavo Integrated Desktop") were measured deviations between reference position (habitual occlusion) and recorded condylar positions during active (CO) and passive (RCP) recording of the CR. All deviations were measured for the left and the right mandibular condyle: deviations at anterior – posterior axis (x), deviations at vertical axis (y) and deviations at lateral axis (z). Left – right side differences were compared using depended samples T test. Deviations at the level of left and right condyles were treated as a one sample, as in most of similar investigations [17, 18]. Beside deviations at the level of Cartesian coordinate system, linear deviation values between reference position and condylar position during active (CO) or passive (RCP) recording of the CR were calculated. Descriptive statistics was calculated (SPSS Statistics 17.0). Deviation values between habitual occlusion and RCP and deviation values between habitual occlusion and CO were compared using independent samples T test, and values bellow 0.05 were considered statistically significant.

RESULTS

Dependent samples T test did not determined left – right side differences of the x, y, z axis deviation values and of the linear deviation values. Table **1** and **2** show descriptive statistics for condylar deviation values

Table 1: Condylar Deviation Values between Habitual Occlusion and Centric Occlusion for Left and Right Condyles together (N=40) at the Level of x (Anterior – Posterior), y (Vertical) and z (Lateral) Axis. Negative Values for the x Axis Mark Posterior Direction, for the y Inferior and for the z Axis Left Side

	N	Minimum (mm)	Maximum (mm)	Average (mm)	SD
x	40	-0.90	1.40	-0.04	0.56
y	40	-2.20	4.10	0.81	1.40
z	40	-0.70	0.50	-0.06	0.31

Table 2: Condylar Deviation Values between Habitual Occlusion and Retruded Contact Position for Left and Right Condyles Together (N=40) at the Level of x (Anterior – Posterior), y (Vertical) and z (Lateral) Axis. Negative Values for the x axis Mark Posterior Direction, for the y Inferior and Negative Values for the z Axis Mark Left Side

	N	Minimum (mm)	Maximum (mm)	Average (mm)	SD
x	40	-1.00	2.80	-0.04	0.90
y	40	-0.70	7.70	1.79	2.00
z	40	-0.60	0.50	-0.07	0.35

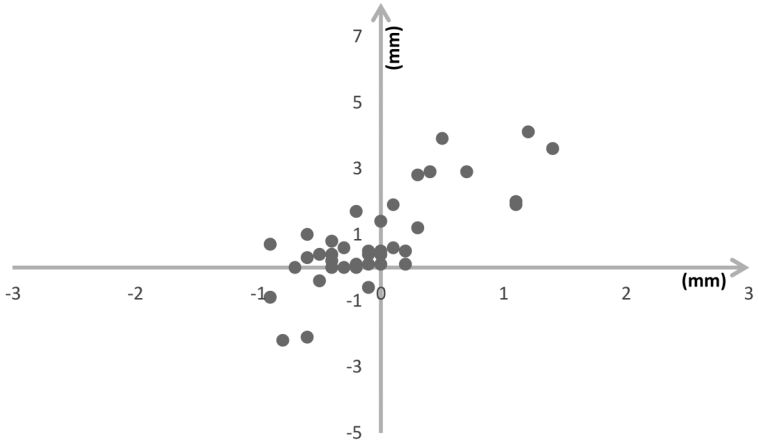

Figure 1: Condylar deviations between habitual occlusion and position of centric occlusion (left and right condyle are one sample); x (anterior – posterior) axis and y (vertical) axis, negative values describe posterior and/or inferior direction.

between habitual occlusion and CO, and habitual occlusion and RCP for all participants. Figures **1** and **2** show condylar deviation values between habitual occlusion and CO, and between habitual occlusion and RCP for all participants. Average linear condylar deviation value for the CO position for left and right condyle together was je 1.30 ± 1.14 mm (min 0.10 mm, max 4.30 mm). Average linear condylar deviation value for the RCP position for left and right condyle together was je 2.13 ± 1.89 mm (min 0.47 mm, max 7.97 mm). Independent samples T test did not determined statistically significant difference between condylar deviation values of the RCP and the CO for the anterior - posterior axis (α=1.0) and lateral axis (α=0.87), while for vertical axis was determined statistically significant difference (α=0.01). Independent samples T test showed statistically significant difference in linear deviation values between RCP and CO positions (left and right side was one sample, α=0.021).

DISCUSSION

The purpose of this investigation was to determine difference between the RCP and CO position.

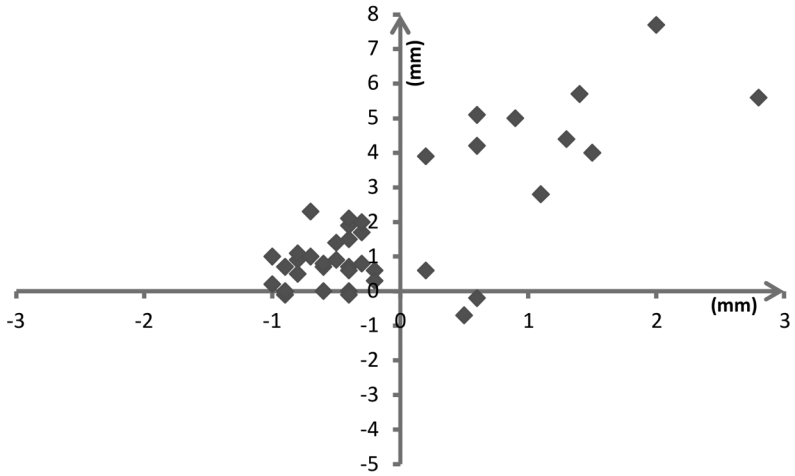

Figure 2: Condylar deviations between habitual occlusion and retruded contact position (left and right condyle are one sample); x (anterior – posterior) axis and y (vertical) axis, negative values describe posterior and/or inferior direction.

Independent samples T test determined statistically significant difference (α=0.021), where RCP had superior position to CO.

Thakur *et al*. [19] studied CR position using gothic arch tracing method and interocclusal wax records. Authors concluded that the CR position depends on the used method, and that variations between different methods of the CR recording can be up to 0.5 mm. Results of the present study are in accordance with the study of Thakur *et al*. [19], and with other studies that found difference between different methods of the CR obtaining methods [4, 8, 10].

Swenson *et al*. [4] investigated 5 different methods of the CR recording using condyle position indicator. Authors concluded that condylar position within temporomandibular joint varies between methods. Chin point guidance and bimanual manipulation positioned condyle more inferior and posterior. De Bragança *et al*. [14] using an mandibular tracking system obtained on average inferior and anterior condylar position of CR (bimanual manipulation and long strip technique system) compared to habitual occlusion. Results of the present study (Table **1** and **2**) are opposite to study de Bragança *et al*. [14] and Swenson *et al*. [4], while superior condylar direction is in accordance with the study of Celar *et al*. [8] and Linsen *et al*. [12]. Although superior condylar position corresponds to the last definition of the CR according to "The glossary of prosthodontic terms" [2], authors agree with Alvarez *et al*. [10] that anterior, posterior or superior condylar direction is not the most important part of the definition. Rather than highlighting the condylar position it should be emphasized that CR is muscular – skeletally stabile position, with correct position of the articular disc, without compression of the surrounding tissues and with minimal activity of the lateral pterygoid muscle.

Although RCP and CO in a professional and scientific sense are mostly considered as a one position, it is expected that with passive methods of the CR recording definition of the occlusion at CR position will be closer to RCP. With active methods without therapeutic guidance definition of the occlusion at CR will be closer to the CO.

Celar *et al*. [8] investigated guided and unguided mandibular reference position of the lower jaw (CR) in asymptomatic participants. Bimanual guidance positioned the condylar spheres, on average, 0.1 mm more right and 0.6 mm more posterior and superior to unguided hinging. Results of the Celar *et al*. [8], which are in accordance with present study results (average difference between two methods of the CR recording was 0.83 mm), favors two separate condylar positions; position of the RCP and position of the CO. Despite determined differences it should be noticed that positions of RCP and CO are at least partially overlapping. Beside study of Mckee [20], where a group of dentists using bimanual manipulation repeated condylar position within the 0.11 mm tolerance of the Denar Centri-Check instrument in 106 of 110 attempts, literature describes variability of the CR position [21-23]. Studies also determined differences in condylar positioning between different methods of the CR recording [4, 8, 10, 19]. Several authors question the CR as a one rigid point [9, 21-23]. Free CR could be more related to the physiological activity of the jaw than just restricted to a single position [9, 23]. With this in mind, CR could be defined within temporomandibular joint as an area with its height and length. Considering

the results of different investigations [4, 8, 10, 19] (Table **1** and **2**), it can be expected that different techniques of the CR recording will (likely) position condyles within different CR area. With different methods of the condylar deviations measurement (condyle position indicator [6, 8], magnetic resonance [24, 25], different mandibular recording devices [13, 14, 26]), different samples and expected differences between researchers in mind, it would be difficult to divide CR area into parts with different probability for condylar positioning with certain CR recording technique.

CONCLUSION

Different methods of the CR recording will lead to different condylar position within temporomandibular joint. Position of RCP and CO can be observed as a two different occlusal and condylar positions. On average, condylar position in CR will be superior to the position of habitual occlusion.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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