Published online: 2019-09-23

Original Article

Differences between centric relation and maximum intercuspation as possible cause for development of temporomandibular disorder analyzed with T-scan III

Zana D. Lila-Krasniqi[1], Kujtim Sh. Shala[1], Teuta Pustina-Krasniqi[1], Teuta Bicaj[1], Linda J. Dula[1], Ljuben Guguvčevski[2]

[1]Department of Prosthetics, Faculty of Medicine, School of Dentistry, Pristina, Kosovo, [2]Department of Prosthetics, Faculty of Dentistry, Skopje, Macedonia

Correspondence: Dr. Zana D. Lila-Krasniqi
Email: zana.lila.krasniqi@gmail.com

ABSTRACT

Objective: To compare subjects from the group with fixed dentures, the group who present temporomandibular disorders (TMDs) and a control group considering centric relation (CR) and maximum intercuspation (MIC)/habitual occlusion (Hab. Occl.) and to analyze the related variables also compared and analyzed with electronic system T-scan III. **Materials and Methods:** A total of 54 subjects were divided into three groups; 17 subjects with fixed dentures, 14 with TMD and 23 controls-selection based on anamnesis-responded to a Fonseca questionnaire and clinical measurements analyzed with electronic system T-scan III. Occlusal force, presented by percentage (automatically by the T-scan electronic system) was analyzed in CR and in MIC. **Results:** Data were presented as mean ± standard deviation and differences in $P < 0.05$ were considered significant. After measurements of the differences between CR and MIC in the three groups were noticed varieties but the $P > 0.05$ it was not significant in all three groups. **Conclusion:** In our study, it was concluded that there are not statistically significant differences between CR and MIC in the group of individuals without any symptom or sign of TMD although there are noticed in the group with TMD and fixed dentures disharmonic relation between the arches with overload of the occlusal force on the one side.

Key words: Centric relation, dental occlusion, maximum intercuspation, temporomandibular disorder

INTRODUCTION

Temporomandibular joint (TMJ) function has been the subject of considerable study for over a century, and despite voluminous literature, the multifactorial etiology of on TMD even today is a unsolved issue.[1]

There are over 26 definitions for Centric Relation (CR) since the term was first developed as a starting point for making dentures.[2,3]

Definition of CR needs to be clinically oriented, to lessen the confusion and controversies, by eliminating clinically invisible parts from the definition. The acceptance of one definition is necessary to improve communication at all levels of dentistry.[2]

There is no one ideal position of the condyle in the glenoid fossa, but there is a range of normal position.[4-10]

Celenza concluded that there might be several acceptable CR positions.[11] Serrano in 1984 agreed

How to cite this article: Lila-Krasniqi ZD, Shala KS, Pustina-Krasniqi T, Bicaj T, Dula LJ, Guguvcevski L. Differences between centric relation and maximum intercuspation as possible cause for development of temporomandibular disorder analyzed with T-scan III. Eur J Dent 2015;9:573-9.

DOI: 10.4103/1305-7456.172627

with this by stating that CR is not only one position but a range of positions.[12]

CR it has also been described as the most stable and comfortable position of the mandible in which the joints can be loaded without discomfort.[13]

Although the previous and present glossary of prosthodontic terms definitions are diametrically opposite to each other, methods to record CR remained the same.[14,15]

CR is being discussed under the heading of jaw relations so it is logical to discuss it in relation to maxilla and mandible rather than the head of condyles and its position. Most of the controversies are related to the position of the clinically invisible parts the head of the condyle in the glenoid fossa during CR position.[2] This ranges from a retruded posterior position, to superior position and then to an anterior superior position.[3,16]

With greater understanding of the mandibular movements the concept of antero-superior position of the head of the condyle may change again in future.[17]

A missed CR destroys the accuracy of even the most sophisticated instrument system and can lead to failure of a prosthodontic treatment.[18]

There is hardly any aspect of clinical dentistry that is not adversely affected by a disharmony between the articulation of the teeth and the centric relation position of the temporomandibular joints.[19]

The position of MIC is defined as the position of the occlusal relationship in which the teeth of both arches are mostly interposed independent of condylar position. [20-24] MIC also known as Centric Occlusion: this position is dictated by the teeth themselves, determined when the patient habitually self-closes into complete tooth intercuspation.[6,20,21,24-26]

Therefore, after conducting direct or indirect restorations, a careful analysis of occlusal contacts should be performed, in order to avoid the creation of iatrogenic interferences that can produce the signs and symptoms of TMD and postural disorders.[27,28] These interferences can be formed by uneven tooth wear, but also by restorative procedures performed incorrectly, which can leads to a disharmonic relation between the arches.[29-34]

In the other hand, several studies have shown that in most cases the neuromusculature places the mandible in such a position that the highest number of occlusal contacts is established without taking into account the final condylar position.[20,22,26] However, the role of condylar displacement in the context of morphologic and functional occlusion could be the risk factor in TMD development.[2,14-16,20,26,35,36]

The aim of this study is to compare subjects from the group with fixed dentures, the group who present TMD, and a control group (CG) considering CR and maximum intercuspation (MIC) and to analyze the related variables also compared and analyzed with electronic system T-scan III.

MATERIALS AND METHODS

This research has been realized in:
- Faculty of Medicine, School of Dentistry, Pristina, Kosovo and in
- Faculty of Dentistry, Skopje, Macedonia.

The study population consisted of total 54 subjects. All the subjects are examined clinically by the same trained dentist and answered the questionnaire for TMD-the anamnesis index proposed by the Fonsseca.[16,17]

The study has been initiated after the subjects had signed informed consent forms, and the research program had been approved by the Ethical Committee.

The study population was divided into three groups:
- In the first study group (SG I) were subjects with fixed dentures with prosthetic ceramic restorations
- In the SG II were subjects with TMD
- In the third group-CG were healthy subjects with full arch dentition.

The measurements have been conducted with the T-scan system-the T-scan III computerized occlusal analysis system (Tekscan Inc., South Boston, MA, USA) [Figure 1]. The T-scan III is a bite analysis system that measures the efficiency of how teeth come together and separate. The T-Scan III (Computerized Occlusal Analysis System) is a reliable clinical diagnostic device that senses and analyses occlusal contact forces by means of pressure-sensitive sensors, shaped to fit the dental arch [Figure 1a]. The T-scan sheets (sensor) used, have a layer thickness of 100 μm and are therefore within the range of commercially available articulating foils, papers and silk (8 - 200 μm).[25,39-47] A patient simply bites down on a thin sensor of the handle that is connected with computer and the software displays the timing of contacts and levels of force in a dynamic movie [Figure 1b].

Occlusal force, presented by percentage (automatically by the T-scan electronic system) was analyzed in CR and in MCI.

The measurements and recordings are made in the following order:

1) 1st CR Bite
2) 2nd MCI Bite
3) Right Lateral Excursive Bite
4) Left Lateral Excursive Bite
5) Protrusive Bite

For this research were used only first two measurements for analyzing.

Data analysis

For data were used Statistical Package Statistica 7.1 for Windows (StatSoft.Inc., Tulsa,OK 74104,USA). The data were presented as a mean ± standard deviation, also Kolmogorov–Smimov test, Lilliefors test, and Shapiro–Willks test were used for the distribution of the data at the numerical series. Differences in $P < 0.05$ were considered significant. All data are presented in Tables 1-3.

RESULTS

A total number of subjects were 54. The study population was divided into three groups. The first study group (SG I) analyzed according to gender and age consisted of 17 subjects, 8 (47.06%) men, and 9 (52.94%) females with age range from 22 to 65, mean age 56.35. Second study group (SG II) consisted of 14 subjects, 5 (35.71%) men, and 9 (64.29%) females with age range from 23 to 58, mean age 33.93, and CR consisted of 23 subjects, 6 (26.09%) men, and 17 (73.91%) females with age range from 20 to 35 years mean age 25.43.

Descriptive analyze of the SG I with fixed dentures at Hab. Occl. has high discrepancies between minimal and maximal overload of occlusal forin the left and a right side (min. 18.30%–max. 81.70%). Habitual occlusion (Hab. Occl.) in the left for $Z = -1.98$ and $P < 0.05$ ($P = 0.04$) is significantly higher than in the right side [Table 1].

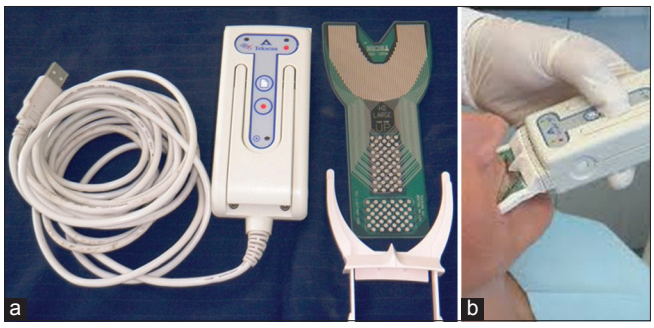

Figure 1: The T-scan III computerized occlusal analysis system (Tekscan Inc. South Boston, MA USA). (a) Handle with Sensores. (b) Measurments with T-Scan III

In addition, CR has a high discrepancy between a minimal and maximal overload of occlusal force on the left and a right side (min.11.40%–max. 88.60%). CR in the left for $Z = -2.08$ and $P < 0.05$ ($P = 0.04$) is significantly higher than in the right side [Table 2].

Descriptive analyze of the SG II with the presence of TMD at Hab. Occl. has high discrepancies between a minimal and maximal overload of occlusal force in the

Table 1: Descriptive statistics/MIC-habitual occlusion (right % and left %)/in three groups

Habitual occlusion Group I	Right (%) (*n*=17)	Left (%) (*n*=17)	*P*
Mean±SD	47.54±14.54	52.46±14.54	0.04
Confidence±95.00%			
Minimum	27.90	18.30	
Maximum	81.70	72.10	
Habitual occlusion Group II	**Right (%) (*n*=14)**	**Left (%) (*n*=14)**	
Mean±SD	51.31±12.50	48.69±12.50	0.58
Confidence±95.00%			
Minimum	27.90	29.20	
Maximum	70.80	72.10	
Habitual occlusion Group III	**Right (%) (*n*=23)**	**Left (%) (*n*=23)**	
Mean±SD	47.27±8.03	52.73±8.02	0.03
Confidence±95.00%			
Minimum	34.40	34.10	
Maximum	65.90	65.60	

MIC: Maximum intercuspation, SD: Standard deviation

Table 2: Descriptive statistics/centric relation (right % and left %)/in three groups

Centric relation Group I	Right (%) (*n*=17)	Left (%) (*n*=17)	*P*
Mean±SD	43.66±19.63	56.34±19.63	0.04
Confidence±95.00%			
Minimum	11.40	15.40	
Maximum	84.60	88.60	
Centric relation Group II	**Right (%) (*n*=14)**	**Left (%) (*n*=14)**	
Mean±SD	43.01±14.27	56.99±14.27	0.02
Confidence±95.00%			
Minimum	19.50	34.60	
Maximum	65.40	80.50	
Centric relation Group III	**Right (%) (*n*=23)**	**Left (%) (*n*=23)**	
Mean±SD		49.94±6.94	0.95
Confidence±95.00%			
Minimum	35.20	36.00	
Maximum	64.00	64.80	

SD: Standard deviation

left and the right side (min. 27.90%–max. 72.10%). Hab. Occl. in the right for $t = 0.56$ and $P > 0.05$ ($P = 0.58$) is not significantly higher than in the left side [Table 1 and Figure 2].

In addition, CR has a high discrepancy between a minimal and maximal overload of occlusal force in the left and the right side (min. 19.50%–max. 80.50%). CR in the left for $t = -2.59$ and $P < 0.05$ ($P = 0.02$) is significantly higher than in the right side [Table 2 and Figure 3].

Descriptive analyze of the III CG at Hab. Occl. has moderate discrepancies between a minimal and maximal overload of occlusal force on the left and a right side (min. 34.40%–max. 65.90%). Hab. Occl. in the right for $t = -2.31$ and $P < 0.05$ ($P = 0.03$) is significantly higher than in a left side [Table 1 and Figure 4].

Also in CR has a similar moderate discrepancy between a minimal and maximal overload of occlusal force on the left and the right side (min. 35.20%–max. 64.80%). CR in the right for $t = 0.06$ and $P > 0.05$ ($P = 0.95$) is not significantly higher than in the left side [Table 2 and Figure 5].

DISCUSSION

Due to the high prevalence and variability of the complaints, TMD is diagnosed by associating signs and symptoms, as some characteristics may be frequent even in a nonpatient population.[40]

After measurements made between CR and MCI in the three groups were noticed differences but the $P > 0.05$ was not significant in the all three groups [Table 3].

In the group with TMD and fixed dentures were noticed disharmonic relations between the arches with an overload of the occlusal force in the one side at both CR and MCI/Hab. Occl.

Table 3: Differences between centric relation-habitual occlusion/right % and centric relation-habitual occlusion/left %/in three groups

Group I	Centric relation (n=17)	Habitual occlusion (n=17)	Z	P
Rank sum right	279.00	316.00	0.64	0.52
Rank sum left	316.00	279.00	−0.63	0.52
Group II	**Centric relation (n=14)**	**Habitual occlusion (n=14)**	**t**	
Mean sum right	43.01	51.31	1.64	0.11
Mean sum left	56.99	48.69	−1.64	0.11
Group III	**Centric relation (n=23)**	**Habitual occlusion (n=23)**	**t**	
Mean sum right	50.06	47.27	−1.26	0.21
Mean sum left	49.94	52.73	1.26	0.21

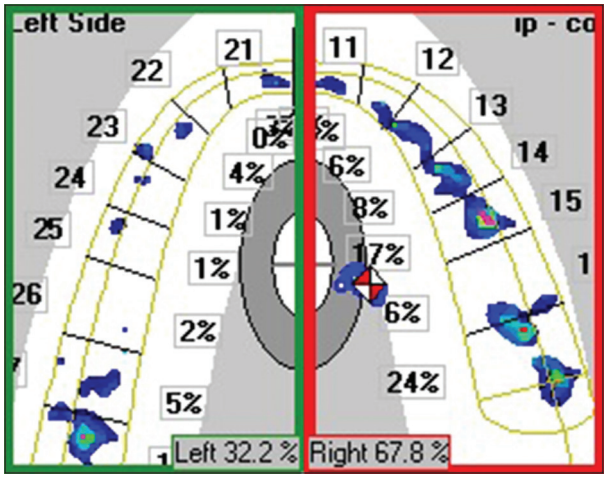

Figure 2: Temporomandibular disorder group maximum intercuspation-habitual occlusion two dimension T-scan

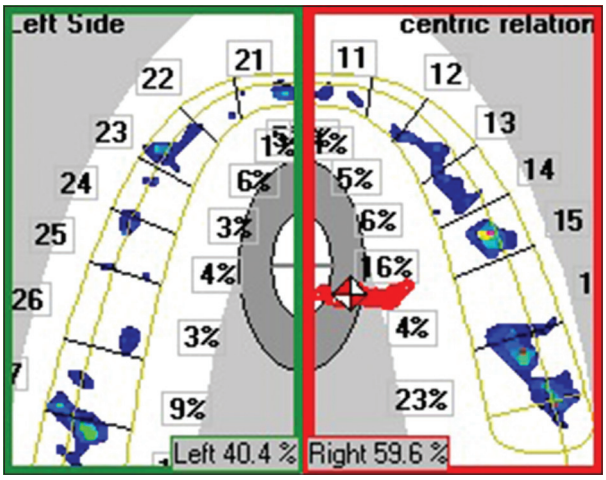

Figure 3: Temporomandibular disorder group centric relation two dimension T-scan

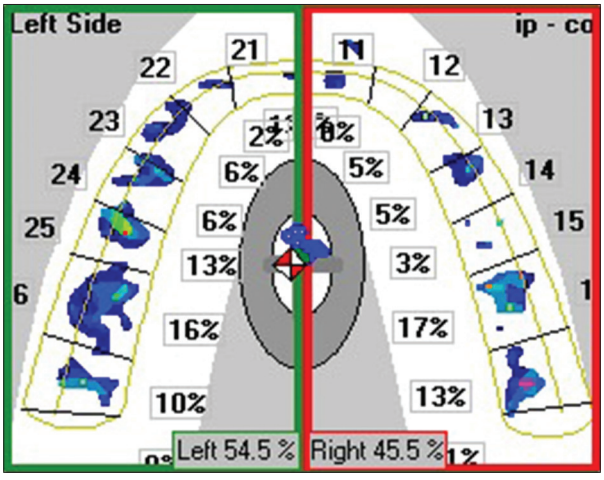

Figure 4: Control group maximum intercuspation-habitual occlusion two dimension T-scan

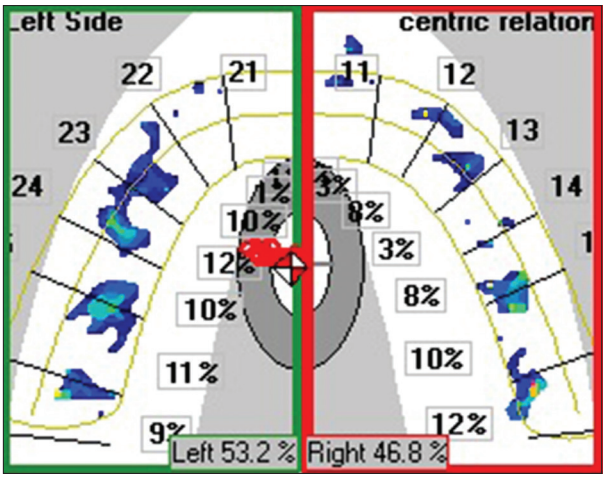

Figure 5: Control group centric relation two dimension T-scan

In order to obtain and compare results from different clinical studies, there was a need for using reliable and valid instruments to measure TMD severity within the sample, which consisted of nonpatient volunteers who could present TMD symptoms[40,41] and for that reason questionnaires have been created to address the main clinical TMD findings and assign clinical indexes for patient classification in terms of severity levels.[37-41,48,49]

In the work published by Magnusson *et al*.,[50] it was concluded that occlusal factors are weakly associated to TMD, though forced laterality between CR and maximum intercuspation, and unilateral crossbite deserve consideration as possible local risk factors in the appearance of TMD.[50,51]

Also Sadowsky and Polson[52] found there was no significant relationship in a study they conducted aimed to find the degree of relationship among occlusal alterations with temporomandibular dysfunction.

The theories of TMD etiology that have made the largest impact are related to various types of occlusal imperfection. Occlusion is a very important subject within the profession of dentistry, especially if it's related to orthodontics, restorative dentistry, and prosthodontics; however, its relevance to the etiology of TMDs is questionable, especially in chronic condition.[51,53]

Previous studies on the performance of occlusal indicators have focused on comparing their sensitivity, reliability, validity and practical, and no study has investigated whether the presence of an indicator affects muscle function during occlusion.[54] According to Forrester,[54] T-scan and articulating paper significantly influence neuromuscular function during occlusion, and therefore, may not represent valid means of identifying occlusal contacts that occur under natural dentition conditions.

Numerous studies have been elaborated in order to highlight the possible differences between the position of CR and MIC.[23,24,55,56] The relationship between occlusion, mastication, and dental disorders is not well understood because of the lack of accurate, quantitative measures of occlusal parameters.[23]

In our study as in several researchers have related that the majority of toothed patients exhibit a discrepancy between the CR and MIC positions.[23,24,56]

Pullinger[57] carried out a study to assess which factors could be associated to TMD. He found that discrepancies between IM and CR position are factors to show individual TMD symptoms.

Controversy continues about what is considered an ideal condyle-fossa relationship when the teeth establish MIC.[20,58] If any premature occlusal contact changes the jaw closing arch, the condyles might be displaced to achieve a maxillomandibular relationship in MIC, thus avoiding premature contact.[20]

It is not clear how occlusal changes (natural dentition development, occlusal treatments, or restoration procedures) affect the function of the TMJ.[21,58] However, in our study comparing results between groups it is clear that occlussal changes affect TMJ and also fixed dentures if they are not well articulated also can affect TMJ in future.

Differences between the CR and Hab. Occl. should not be ignored because depending on the mandibular position also previous studies[20,23,24,56,58] have shown that CR and Hab. Occl. discrepancies are frequently present in the general population, in symptomatic as often as in asymptomatic subjects.

According to the results of this study, the analyzed patients presented differences between these two positions, however, when submitted to a statistic analysis, those differences were not significant. It could be presumed that, in spite of the samples presented various occlusal arrangements, these were in relative balance or were not yet capable of generating alterations condyle/fossa relation.

As in this study also Weffort and Fantini[20] have found a positive correlation between these two positions.

In spite of the great importance of differentiation of these two condylar positions in any dentistry modality and of the results achieved in this study, attention must be given to the fact that each patient has unique features that should be carefully examined in order to obtain a suitable result.

CONCLUSION

According to our examination, we can conclude that there are not statistically significant differences between CR and MIC in the group of individuals without any symptom or sign of TMD although there are noticed in the group with TMD and fixed dentures disharmonic relation between the arches with overload of the occlusal force on the one side.

Reconstruction of harmonious occlusal relationship compared to the antagonist teeth during delivery of new prosthetic restoration is vital because otherwise the patient may have tooth pain after a period of time and changes in the TMJ. The aim of such an intervention is to obtain a stable occlusal relationship, with no premature contacts or mandibular excursion.

A mandibular position that determines occlusal, muscular, and articular balance is required to plan and execute oral rehabilitation, in concordance to the stomatognathic system.

Acknowledgments
The authors acknowledge University "Hasan Prishtina" in Pristina, Kosova that have provided The T-scan III computerized occlusal analysis system with which was possible to facilitate this study.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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