Original Article

DOI: 10.7860/JCDR/2013/5602.3307

Dentistry Section

Digital Evaluation of Functional Occlusion Parameters and their Association with Temporomandibular Disorders

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ABSTRACT

Context: Dental researchers are contradictory in their opinion on the role of occlusion in TMD. Occlusal evaluation of both conventional and digital methods in TMD patients will provide the accurate information about the factors accountable for occlusal instability. Identifying the factors responsible will facilitate precise diagnosis and treatment for TMD.

Aim: The Aim of the study was to determine the dynamic occlusal parameters strongly associated with the etiology of Temporomandibular disorders.

Material and Methods: Study group consisted of 100 patients; it included 50 patients with normal TMJ(Group I) and remaining 50 patients had a minimum of one positive sign or symptom of Temporomandibular disorder (GroupII). The patient's dynamic occlusal contacts were evaluated by both conventional and digital methods. The Articulating paper was utilized for conventional occlusion analysis. During conventional analysis centric, lateral and protrusive interferences were evaluated along with loss of vertical dimension. Digital occlusal analysis was performed with T-Scan III. Clusion time, disclusion times were recorded for both groups. Chi-square and Student 't' statistical analyses were performed to ascertain the association and statistically significant difference between the groups using SPSS19.

Results: Group II patients predominantly (66%)had Group-function occlusion compared to Group I subject. Centric slide more than 2 mm found to have strong influence (p-value 0.008) on the etiology of TMD. Among the occlusal interferences evaluated balanced side interferences had a strong correlation with TMD with P-value of 0.003. Working side interferences, protrusive interferences had a p-value of 0.157, 0.826 respectively, indicating weak association. T-Scan analysis showed Group I had 0.689, 0.9136, 0.7952, 0.9794 seconds of clusion, left, right, protrusive disclusion time respectively compared to corresponding 1.862, 1.7995, 1.6978, 1.9296 seconds for Group II. Statistically significant difference ($p \leq 0.05$) was found between the mean values of both groups.

Conclusion: Among the dynamic occlusal parameters evaluated centric slide and balancing side interferences were found to be highly influential in TMD etiology. TMD patients had prolonged clusion and disclusion times compared to healthy TMJ patients.

Key words: TMD, Occlsual evaluation, T-Scan III, Dynamic occlusal interferences

INTRODUCTION

Large sections of the people across the world suffer from Temporomandibular disorder (TMD). The TMD presents itself with a group of disorders like pain and clicking in Temporomandibular joint, dysfunction associated with pain in the muscles of mastication and limited mouth opening. In many individuals, TMD is known to cause severe masticatory functional disability. TMD is a multifactorials disorder. Significant research efforts have been invested in finding its etiologies. Numbers of etiologic factors are attributed to the onset of TMD. Its symptoms are significantly correlated to para functional habits like bruxism, clenching and masticatory muscle tension [1]. Few Authors believe psychological factors [2], and postural habits [3] also influence the initiation of TMD. The strong positive association between TMD and malocclusion with large muscular discrepancy is postulated by many researchers. Dental researchers are contradictory in their opinion on the role of occlusion in TMD. According to the researchers, strong correlation between occlusal interferences and TMD, occlusal disturbances lead to orthopaedic instability of TMJ and hyperactivity of the muscles of mastication eventually lead into TMD [4]. Occlusal interferences found to have an association with TMD are Retruded condylar position (RCP) to Inter-cuspal position (ICP) slide, balancing, working side and posterior protrusive interferences [5,6]. Patients with group function occlusion found to have more incidences of TMD than canine guided occlusion [7].

Appropriate therapy cannot be initiated unless proper diagnosis is established. The clinician's important task is detecting the type of occlusal parameter strongly correlated with TMD. Conventional methods of occlusal evaluation include articulating papers, impression wax, and shim stock foil. The main disadvantages of traditional methods are; they are two dimensional in nature and do not quantify the occlusal force. Studies have reported that no demonstrable relation between paper mark area and occlusal force [8]. Digital analysis provides additional information on occlusal contact pattern, including the quantification of force, sequence of contact, and occlusal–disocclusal timing. Occlusal evaluation of both conventional and digital methods in TMD patients will provide the accurate information about factors accountable for occlusal instability. Identifying the factors responsible will facilitate precise diagnosis and treatment. It will be helpful in understanding type of occlusal interference and its relation to particular types of TMD signs/symptoms.

The aim of the study was to determine the individual occlusal factor in the etiology of craniomandibular dysfunction utilizing both conventional and digital occlusal evaluation.

MATERIAL AND METHODS

a) Study sample:

Institutional research ethics committee approval was obtained for the study. All participants were explained about the study, obtained the informed consent prior to inclusion in the study. The study sample consisted of 100 patients visiting King Khalid University dental clinics, Kingdom of Saudi Arabia for treatment. Participants were in the age group of 18- 35 years. Subjects were divided into

two groups of 50 each, Group I consisted of patients with normal and healthy temporomandibular joint. Group II patients had one or more positive sign and symptoms of temporomandibular disorders (TMD).

Inclusion criteria for Group II patients were the presence of at least one of the signs/symptoms of TMD. These include pain in the TMJ or muscles of mastication, deviation or deflection of mandible, restricted mouth opening and TMJ clicking/crepitation. Exclusion criterion was known ear, eye or neural disorders.

Group I inclusion criteria was an absence of any of the signs or symptoms for TMD. Static or dynamic occlusal contacts were not criteria considered during the classification of the patient.

b) Examination procedure:

The Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) [9] was used as a guideline in clinical examination procedures. The examination included clinical interview and examination. The clinical interview included collection of the personal information and detailed medical and dental history. Patients were enquired about the history of headache, Pain, discomfort, limitation, noise and trauma in TMJ.

Occlusion, muscle of mastication and TMJ evaluations were done during clinical examination by the single clinician. The patients were examined for tenderness in TMJ by gentle digital palpation, clicking and crepitation were noted by stethoscope auscultation. Mandibular range of motions including maximum mouth opening, extent of lateral and protrusive movements, presence of deviation, deflections were recorded with sterilized stainless steel measuring scale. Muscles of mastication were digitally palpated gently in their respective area for the evidence of myogenic pain. Routine eye and ear examination was as well carried out.

Occlusion was evaluated both by conventional and digital methods. Centric relation was established by the Dawson's bimanual method. If the slide from initial teeth contact (Centric relation) to maximum intercuspation (Centric occlusion) was observed more than 2 mm, it was recorded. Loss of vertical dimension was recorded as positive, if the difference between maximum intercuspation to mandibular resting position is greater than 4 mm. Occlusal scheme in the patient was categorized as Canine guided or group function. A conventional occlusal evaluation was done with double sided articulating paper. Petroleum jelly smeared articulating paper was held between the occluding teeth with Miller's forceps and the subject was requested to make lateral and protrusive mandibular movements.The existence of occlusal interferences of working, non-working and posterior interferences was documented sequentially. T Scan digital occlusal evaluation was initiated by determining dental arch dimensions by measuring Central incisor width. This helped in customizing the graphical dental arch in T Scan software. According to manufacturer's instruction Calibration of intra-oral sensor is required to be adjusted depending on the biting force of the patient. This was accomplished by adjusting the electric charge to have a maximum of three graphical displays. The subject was placed in a supine position, with their body parallel to the floor and head cradled between the arms. While the dentist guided the patient into centric relation, Sensor was held vertically by the dental assistant. Once the centric relation- centric occlusion were recorded, teeth were held together for a full second before commencement of an excursive movement. Sequential recording of lateral and protrusive movements was done. Occlusion (clusion) time was determined by noting the time from centric relation(initial contact) to centric occlusion using force-time graph in T Scan analyzer. Disclusion time was also recorded by observing time needed for dis-occlusion of teeth from maximum inter-cuspation to lateral or protrusive movements. Three successive recordings were conducted to validate the each centric relation, lateral movements and occlusal interferences.

c) Statistical methods:

The data collected was analyzed by Chi-square statistical analysis to identify the possible correlation between occlusal parameters and TMD. T-Scan data were computed and analyzed by the student T test at the 5% critical level ($p \leq 0.05$) using SPSS 19 to determine the existence of statistically significant difference between the groups.

RESULTS

A) Occlusal interference and TMD

[Table/Fig-1] illustrates the Chi-square statistical analysis between occlusal interferences and TMD. Significance in the relation between occlusal contact and TMD was evaluated by Chi-Square test. Among the 100 patients evaluated, the sample included 55 subjects with canine guided occlusion, 45 of them had group function occlusion. Positive TMD was observed in 66% of the patients with group function occlusion. As shown by the frequencies tabulated in [Table/Fig-1] Chi-square value was 4.889 and p-value of 0.027 indicating the strong association between type of occlusion and TMD.

[Table/Fig-1] also suggests the significant relationship between Centric slide more than 2 mm with joint disorders, Chi-Square value of 7.111 and p-value of 0.008 was observed for this parameter. Among the occlusal interferences evaluated the relation between balancing side interferences and TMD was significant, while working side interference and protrusive interferences had an insignificant relationship. Balancing side interferences had χ^2 Value 9.004, p value0. 003. χ^2 Value of 1.999, 0.049 and p values of 0.157, 0.826 was observed in working side and protrusive interferences respectively. Loss of vertical dimension had a p-value of 1.000, hence had statistically insignificant influence on joint disorder.

B) Comparison of T scan dynamic occlusal parameters between normal (I) and TMD (II) groups

The student t-test was performed to compare the means from T scan data from both the group to find the statistical difference [Table/Fig-2]. The clusion time for group I was 0. 6910±0.3266seconds, compared to 1.8618±0.5825 seconds for group II patients. Left disclusion time recorded for the group I and group II was 0.9136± 0.2385, 1.6978±0.4727 seconds respectively. Similar patterns of disclusion time was observed in the right side too, Group I had 0.7952±0.2502 seconds, Group II showed 1.7996±0.4236 seconds. The protrusive disclusion time recorded was 0.9794± 0.253 seconds in the Group I and 1.9296±0.41335 seconds for Group II. The results conclusively showed the Clusion time, protrusive disclusion time and lateral disclusion time in the Group II patients were consistently longer than Group I. All the criterias evaluated by T Scan had a p-value less than 0.05, indicating an existence of statistically significant difference between the groups.

	Type of occlusion	Slide from CR-CO	Balancing interferences	Working interferences	Protrusive interferences	Loss of Vertical height
Chi-Square	4.889*	7.111*	9.004*	0.049*	1.999*	0.000*
Df	1	1	1	1	1	1
Asymp.sig (2sided)	0.027	0.008	0.003	0.826	0.157	1.000

[Table/Fig-1]: Chi-Square statistical test of significancebetweenocclusal interferences and TMD.

*0(0%) cells have expected frequency less than 5
Significance at 0.5% level of confidence (p<0.05))

Groups	Mean	SD	t-value	p-value	Significance
Clusion time Gr I	0.6910	0.3266	-11.515	<0.01	S
Clusion time Gr II	1.8618	0.5825			
LT DisCl Gr* I	0.9136	0.2385	-9.983	<0.01	S
LT DisCl Gr II	1.6978	0.4727			
RT DisCl** Gr I	0.7952	0.2502	-13.821	<0.01	S
RT DisCl Gr II	1.7996	0.4236			
PT DisCl*** Gr I	0.3467	0.2662			
PT DisCl Gr II	0.6033	0.4133	-15.081	<0.01	S

[Table/Fig-2]: Student 't' test for T-Scan clusion and disclusion mean values
*LT DisCl- left disclusion time,**RT DisCl-Right disclusion time, ***PT DisCl-protrusive disclusion time.
Significance at 0.5% level of confidence(p<0.05)

DISCUSSION

The etiology of temporomandibular disorder (TMD) is multifactorial. Though occlusion is considered to play a bigger role in initiation of disorder, it is not being conclusively demonstrated. Mandibular dysfunction due to TMD is a result of functional malocclusion than the morphological malocclusion. Excessive load on the masticatory system due to occlusal instability eventually gives rise to temporomandibular damage. The influence of occlusion on the onset of TMD is debated and still a source of controversy [10-14]. The detailed, exhaustive study of these factors will help in furthering the knowledge on the possible existence of the association. Correct understanding of dynamic occlusion is very critical in differentiating between the normal and pathological occlusal parameters. Digital evaluation of the occlusion by T scan will provide additional information like clusion and disclusion time on functional occlusion. T scan analysis enables the clinician to evaluate the occlusal contacts quantitatively, also record the occlusion during continuous mandibular movement.

In the present study, occlusion was evaluated by both conventional and digital method to understand the parameters associated with occlusal instability and TMD.

The results of the study showed statistically significant difference (P=0.027) in the type of occlusion between TMD and control group. The majority of subjects in positive TMD group (Group II) had Group-function occlusion (66.0 %), while Group I control group had predominantly canine guided occlusion.It is observed by numerous researchers [15] canine is best suited to resisting horizontal forces and the first option for disoccluding all posterior teeth during excursive movements. Previous studies [16] were observed the least muscle activity was found in canine guidance compared with posterior teeth contact during excursive movements. Less muscle activity significantly reduces the force on to the dental and joint structures and subsequent permanent structural damage.

Among the occlusal interference evaluated, balancing side interferences found to have statistically significant correlations with TMD (p value 0.003). Working side and protrusive interferences had P value of 0.826, 0.157 respectively, indicating a poor correlation with TMD. The findings of the study are in confirmation with other researchers like Al Hadi et al., and Shiau YY et al., [7,17]. Balancing side interferences are highly destructive for joint and dental structure due to the amount and direction of force generated. Studies have indicated neuromuscular system perceives the balancing side interference differently compared to other interferences. EMG studies [18] have shown muscle activity found to be highest in the balancing interferences compared to other functional interferences.

Slide from centric relation to centric occlusion more than 2mm is considered as a most important occlusal parameter responsible for joint pathosis [19,20]. From initial tooth contact (Centric relation) to maximum intercuspal position (Centric occlusion) shifting of the mandible is observed in most of the patient within the range of 1-2 mm. This slide is known as the centric slide, it leads to mandibular instability if it exceeds more than 2mm [5]. These will further cause the muscle bracing of condyle and joint pathosis.The results of the study reconfirmed the strong influence of centric slide more than 2 mm on initiation of /TMD with observed p-value of 0.008 [21].

Loss of vertical dimension evaluated in the study had the p-value of 1.000, indicating its statically insignificant correlation with the etiology of TMD.

Timed occlusal contacts during clusion and disclusion time were precisely recorded by T Scan III system [22]. In the study, both laterotrusive as well as protrusive disclusion times were calculated. The Clusion time for group I was 0.689 seconds compared to 1.862 seconds in group II subjects. Clusion time for the Group II (TMD) subjects was significantly longer than group I subjects. The statistical analysis showed the p-value 0.000, indicating the statistically significant difference between the groups. The Group II had Left lateral disclusion time of 1.7995 seconds, right lateral disclusion time 1.6978 seconds and 1.9296 seconds of protusive disclusion time, the corresponding values for Group I were 0.7998,0.9228,0.9794 seconds. Results showed the similar pattern of clusion time with Group II (TMD) had substantially longer disclusion times compared to non TMD (Group I) subjects. The researchers [23,24] have observed the shorter disoccluding time is in the benefit of dental and joint structures. Extended disclusion time leads to increased EMG activityof masticatory muscles and stress on articular disc ligaments [25].

Clinicians should preferably focus on identifying and correcting the deleterious functional and para-functional forces than static lateral occlusal contacts [26]. The occlusal components which are associated with TMD should be carefully evaluated [27], and these findings are useful in the prevention, diagnosis and treatment of Temporomandibular disorders.

CONCLUSIONS

The Functional dynamic occlusal contacts were evaluated by conventional and T Scan analysis for subjects with TMD and normal (control) joints. Within the limitations of the study, it can be concluded that the balancing interferences and centric slide more than 2 mm found to have a strong association with TMD. The study also indicates the subjects with the group function occlusal scheme are more susceptible to temporomandibular disorders. The T scan III results showed both occlusion time and disclusion time in the patients with TMD disorders are significantly extended than the normal subjects.

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FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Jan 08, 2013**
Date of Peer Review: **May 28, 2013**
Date of Acceptance: **Jun 13, 2013**
Date of Online Ahead of Print: **Jul 19, 2013**
Date of Publishing: **Aug 01, 2013**