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Change in the Number of Occlusal Contacts Following Splint Therapy in Patients with a Temporomandibular Disorder (TMD)

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Abstract - *The mean number of occlusal contacts before and after occlusal appliance therapy were compared in three temporomandibular disorder groups and one control group. Only patients with a successful treatment outcome were considered in the statistical analysis. Statistically significant changes were seen in the disc displacement with reduction group, which was managed with anterior repositioning splint: the mean number of contacts increased 3 months after weaning off the splint. If the disc is out of position then the number of occlusal contacts appears to be reduced. It would therefore appear to be sound advice not to make permanent and irreversible adjustment to the occlusion in the presence of disc displacement as when the disc is repositioned occlusal contacts will change.*

KEYWORDS: TMD, occlusion, splint

INTRODUCTION

It has been suggested that masticatory function is dependent on the state of the dentition, particularly on the number and quality of occlusal contacts[1].

Juniper[2] suggested that following displacement of the temporomandibular joint (TMJ) disc, the condyle may also become displaced and the relationship of the lower teeth to the upper teeth changes resulting in premature contacts.

Agerberg and Carlsson[3] reported an increasing frequency of symptoms of temporomandibular disorders (TMD) when the number of occlusal contacts decreased because of missing functional units of the dentition.

Riise and Sheikholeslam[4] postulated that subjects with the lowest number of occlusal contacts demonstrated mandibular dysfunction. Wänman and Agerberg[5] and Yemm[6] suggested that the number of contacting teeth in centric occlusion (CO) had an influence on occlusal stability and on the prevalence of symptoms of mandibular dysfunction reporting that those with fewer contacting teeth reported more symptoms of dysfunction.

Gianniri et al[7] investigated the relationship between the number and distribution of occlusal contacts in 56 subjects aged 16-17 years using a photo-occlusal recording technique and clinical examination. They concluded that there appears to be an association between the number of occlusal contacts in CO and TMD.

Berry and Sing[8] investigated the change in occlusal contacts before and after electromyographic therapy using articulating paper. They reported that uneven or deflective occlusal contacts became apparent with fatigued muscles.

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Greene and Laskin[9] suggested that the success of splint therapy confirms the presence of occlusal disharmonies and the role of the occlusion in the aetiology of a TMD. However, in their study of 71 patients with myofascial pain (MP) there was no reference to examination of the pre existing occlusion and their hypothesis must, therefore, be questioned. Singh and Berry[10] investigated the change in occlusal contacts following the use of soft occlusal splints and they concluded that occlusal change is to be expected when splints are used. However, the sample size was very small (only 10 patients) and in addition, no reference was made in their study to a valid technique of recording occlusal contacts. Solberg et al[11]; Fujii[12]; Klineberg[13] supported the view that despite the general controversy about the relationship between occlusion and TMD, the occlusion is clearly a substantial feature worthy of examination in TMD patients. It is therefore sensible to consider that the occlusion should be examined before and after the relief of symptoms.

Fujii[12] treated 45 patents with an internal derangement (TMJ clicking) by the use of occlusal flat surfaced splints and examined the static and dynamic occlusal contacts just after splint usage and after the relief of clicking. By comparing this group of patients with 60 asymptomatic controls, a significantly lower number of occlusal contacts in CO was reported in the patient group. The same author concluded that in order to avoid the recurrence of eminence clicking, efforts should be made to raise the number of contacting teeth in CO. In a more recent study, Fujii[14] compared the occlusal contacts of 52 TMJ arthrogenous pain (arthrogenous) patients and 27 myogenous muscle pain (patients with that of 60 asymptomatic controls. Occlusal examination in patients was administered just after the relief of pain by splint therapy alone. No significant differences in the number of occlusal contacts in CO were found in the three groups. However, no pre-treatment records of occlusal contacts were made in either of the two studies.

A review of the literature indicates the need for a revised, precise and practical methodology to determine and categorise occlusal contacts for use in dental research, thereby enabling completion of a precise record of the static and dynamic occlusion and providing a basis for a better understanding of the aetiogical role of occlusion in TMD. It appears germane to investigate and detect the changes in occlusal contacts after the completion of splint therapy.

Aim of the Study

The purposes of this study were:

1. To detect any spontaneous change in the number of occlusal contacts in TMD patients and asymptomatic controls.
2. To investigate the change in the number of occlusal contacts pre and post conservative, reversible and non-invasive treatment (splint therapy) in successfully treated TMD patients using a scientific methodological design.

MATERIALS AND METHODS

The control group were 54 symptom free undergraduate students and dental nurses at the University Dental Hospital of Manchester and consisted of 41 women and 13 men. A female to male ratio of approximately 3:1.

Occlusal contacts were recorded for this group at the initial examination and at a review appointment four months later.

The patient subjects were 219 patients (mean age= 34) from new referrals to the University of Manchester Dental Hospital TMD Clinic who were suffering from symptoms and/or signs of a TMD. This group consisted of 148 women and 71 men (female to male ratio of approximately 2:1). Ethical committee approval was obtained.

Patients were divided into three groups by virtue of the clinical diagnosis. The Research Diagnostic Criteria[15] was adopted as a diagnostic system.

- *Myofascial Pain (MP) Group:* This group comprised patients who had more than one of the following signs or/and symptoms in any combination or number: Pain on palpation of the TMJ, pain on palpation of the associated muscles, limitation or deviation of mandibular movement. Headache and clicking may also be present but when considered alone were not diagnostic of MP. These patients received treatment with a stabilisation splint (SS) and comprised seventy-two patients.
- *Disc Displacement with Reduction (DDçR) Group:* This group comprised patients who exhibited a consistently present click from one or both joints. Reciprocal TMJ clicking was regarded as being representative of the internal derangement of disc displacement with reduction. In addition to lateral palpation and intra-auricular palpation of the TMJ via the external auditory meatus, this was detected by using a stereo stethoscope. If it could be determined that the click disappeared with anterior positioning of the mandible, this group received treatment with an anterior repositioning splint (ARPS) as an occlusal appliance and comprised sixty-six patients.
- *Bruxism Group:* This group comprised patients who exhibited signs of active bruxism such as accelerating attrition, tongue scalloping or ridging of the buccal mucosa which is usually along the occlusal line. The soft tissue signs are caused by thrusting the lateral border of the tongue and the cheek mucosa against the surfaces of the teeth during parafunction. These patients received treatment with a localized occlusal interference splint (LOIS)[26] and comprised eighty-one patients.

The following inclusion and exclusion criteria were adopted.

Patients were included in the study if they exhibited the aforementioned signs and symptoms of MP, DDçR, and/or bruxism which were verified by history taking and clinical examination. There was an absence of degenerative systemic disease, recent orthodontic treatment or trauma affecting the temporomandibular joints or articulatory system. Patients with poorly controlled epilepsy who were considered to be inappropriate for splint therapy were excluded from this study.

The patients were aged between 15 and 70 years. Below 15 years it was determined that the use of an anterior repositioning splint would be inappropriate as this might act in the same way as a functional orthodontic appliance.

The patients were required to have a stable and satisfactory occlusion with no missing functional units and no removable prostheses. No previous occlusal therapy prescribed because of the disorder.

The clinical examination was performed according to routine procedures used in the TMD Clinic of the University Dental Hospital of Manchester and have been described elsewhere Gray et al[16,17]. Two collation documents were completed. The first recorded details of the history and symptoms of the present complaint, any relevant oral parafunction, and stress factors. The second noted details of the clinical examination.

Occlusal Contact Records

Occlusal contacts were recorded for the three groups as follows

At the initial examination (R1), at splint fit visit (R2) and at 3/12 after weaning off the splint (R3).

The 'occlusal sketch' technique[18] was used to record the occlusal contacts. In order to define locations of occlusal contacts. The anatomical regions described by DeLong et al[19] were traced onto each occlusal sketch after completing the occlusal record for every patient. This recording method involves the clinician recording static and dynamic occlusal contacts at the chairside using articulating papers held in Miller's forceps. The observed contacts were transferred to an acetate sheet containing a schematic representation of the upper and the lower arches. The acetate comprises of a diagrammatic record of the upper and lower teeth and the marks produced on the specific cusps intra-orally were directly transferred to the corresponding sites on the acetate.

Statistical Analysis

The statistical analysis was carried out using a standard SPSS package. The findings of the change in the number of occlusal contacts were subjected to the t-test for paired observations. A 0.05 level of significance is used.

RESULTS

Four patients in the MP group continued to have signs and symptoms after wearing the splint for 6 months and three patients in the DDçR group had a recurrence of the clicking after weaning off the splint. They were, therefore, excluded from the post treatment analysis of occlusal contacts.

Four patients in the bruxist group were excluded from the analysis because two had developed tooth wear in the canine region and the other two continued to exhibit signs of active bruxism at the end of the treatment.

The patients successfully treated with occlusal splints in each respective group were, therefore, as follows

- MP Group 68 patients
- DDçR Group 63 patients
- Bruxist Group 77 patients

In the *Control Group*, occlusal contacts were recorded at the initial examination visit and four months later. The four-month interval between the two records was calculated to simulate the time period which elapsed in the patient group to permit time for treatment. The second records were made to investigate whether there was any spontaneous variation in the occlusal contacts between the two visits. Comparison of the two recordings revealed there was no significant change (33.5/34.0).

In the MP Group, to detect whether there had been any spontaneous change in occlusal contacts, records at the initial exam and at the splint fit visit were made. There was no significant change in the measurements of occlusal contacts between the two records (35.2/35.0). The final review records were compared to the first and second treatment review records to detect whether there were any occlusal changes following splint therapy. No significant change in the mean number of occlusal contacts between first and final reviews (35.2 /34.8)

In the *Bruxism Group*, once again in this group of patients, it can be seen from Tables 1 and 2 that there was no significant change in the number of occlusal contacts (37.0 /36.1) between the initial exam and at the splint fit visits. No significant change in occlusal contacts between first and final reviews was observed (37.0/ 36.4).

In the *DDçR Group*, there was no change between the initial exam and at the splint fit visits for this group (25.3 / 26.2). However, a significant change in the number of occlusal contacts between the first review and the final review was observed in this group (25.3/ 34.5) (P<0.05).

Comparison of the three groups showed a statistically significant difference only in DDçR Group ($p< 0.05$).

The findings of the change in the number of occlusal contacts in all groups are presented in Tables 1,2,3 and figure 1.

DISCUSSION

The aetiology of TMD is often complex and multifactorial. The significance and role of occlusal factors has been strongly debated for many years[20,21,22,23]. The research data do not offer conclusive evidence for either side of this debate. Despite the controversy, the occlusion, as part of the articulatory system, is obviously an important feature in TMD patients and a detailed examination and recording of the patients' static and dynamic occlusion is essential to the successful diagnosis and management of these patients.

When an evaluation of the relationship between occlusal factors and TMD is made, both the static and dynamic occlusion should be considered. To date, most occlusal studies have assessed only the static relationship of the teeth. The studies cited previously considered the significance or non-significance of occlusal factors only when clinical TMD signs and symptoms were present. The findings were not conclusive in relation to any single factor being consistently associated with a TMD. In addition to assist in the understanding of the relationship between occlusal factors and TMD, occlusal contacts should be investigated before and after the relief of TMD signs and symptoms. Although the effectiveness of different types of occlusal splints in the treatment of different TMD diagnoses has been investigated in many studies, no attempt was made to analyse either the static or the dynamic occlusal contacts before and after splint therapy in any of these studies.

The present study attempted to detect whether there was any spontaneous change in the static occlusal contacts in three TMD patient groups and in an asymptomatic control group and also to investigate whether the occlusal contacts in CO change or do not change with the relief of TMD symptoms. In addition, this study explored the change in the dynamic occlusion post-splint therapy using a scientific methodological design. In the present study, the occlusal sketch technique was used. This technique has been designed to allow for a high degree of inter and intra-operator reliability when recording occlusal contacts. This technique was modified in a manner described by DeLong et al[19] that allowed computer analysis.

Control Group

The findings regarding the unchanged occlusal contacts between first and second reviews in the four groups studied agree with the results reported by Molligoda et al[24] and Molligoda et al[25] In these two studies, the authors investigated the diurnal variations of the occlusal contacts and reported that the variations were not statistically significant and were random in nature.

MP Group

This group received treatment with a stabilization splint as an occlusal treatment for MP. The full arch stabilisation appliance provides an advantage over other designs because it can be adjusted to provide an ideal occlusion in the static and dynamic occlusal situation. The final review records were compared to the first and second treatment review records to detect whether there were any occlusal changes following splint therapy. These findings are presented in Table 1 and Table 3 and show no significant

Table 1. *The mean total number of occlusal contacts at Review 1 (R1) for the myofascial pain (MP) group, bruxism group, and disc displacement with reduction (DDçR) group, were 35.2, 37 and 25.3 respectively. In the control group, the mean number of occlusal contacts at Review 1 (R1), Review 2 (R2) was 33.5.*

Group	*Number Of Patients*	*Mean Number Of Occlusal Contacts At R1*	*Std. Deviation*
MP	68	35.2	6.1
Bruxism	77	37	6.5
DDçR	63	25.3	7.2
Control	54	33.5	5.1

Table 2. *At Review 2 (R2) total number of occlusal contacts for myofascial pain MP group, bruxism group, and disc displacement with reduction (DDçR) group were 35, 36.1 and 26.2 respectively. In the control group, the mean number of occlusal contacts at R2 was 34. There was no statistically significant difference between Review 1 (R1) and Review 2 (R2) records in this group.*

Group	*Number Of Patients*	*Mean Number Of Occlusal Contacts At R2*	*Std. Deviation*
MP	68	35.0	6.8
Bruxism	77	36.1	6.1
DDçR	63	26.2	7.0
Control	54	34.0	5.8

Table 3. *At Review3 (R3) after weaning off splint therapy, the mean number of occlusal contacts for myofascial pain (MP) group and brusixm group were 34.8 and 36.4 whereas the mean number of occlusal contacts for disc displacement with reduction (DDçR) group at Review 3 (R3) had increased to 34.5. Comparison of the three groups showed a statistically significant difference only in disc displacement with reduction (DDçR) group ($p < 0.05$) (Fig.1).*

Group	*Number Of Patients*	*Mean Number Of Occlusal Contacts At R3*	*Std. Deviation*
MP	68	34.8	6.8
Bruxism	77	36.4	5.9
DDçR	63	34.5	5.1

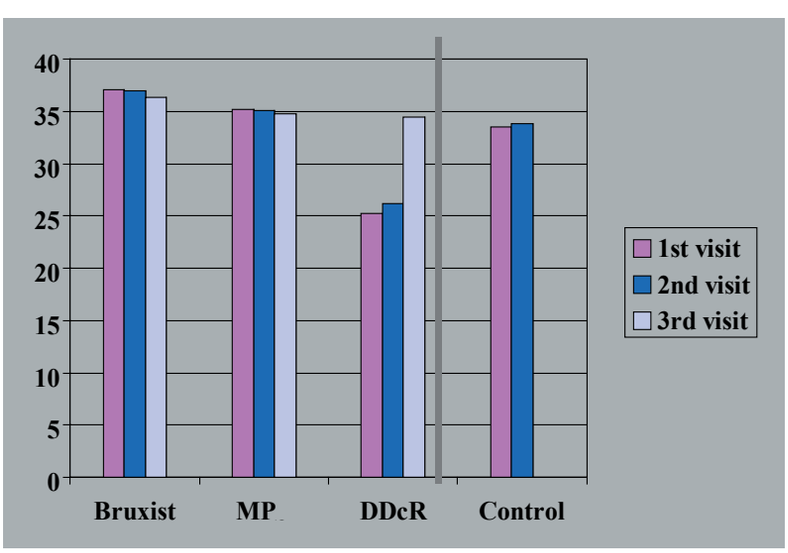

Figure 1. *Bar chart of the mean number of occlusal contacts for the four groups at 1st review (R1) and 3rd review (R3) showing a statistically significant increase in the number of occlusal contacts in the disc displacement with reduction (DDçR) group after splint treatment.*

change in the mean number of occlusal contacts between first and final reviews.

Bruxism Group,

This group received treatment with a LOIS as an occlusal appliance.

once again in this group of patients, it can be seen from Tables 1 and 2 that there was no significant change in the number of occlusal contacts between the two visits. The slightly larger (although not statistically significant) number of occlusal contacts in this group when compared with the other two patients groups, might be explained either by the increase of forceful biting caused by clenching in CO and the increase in masticatory muscle activity. Alternatively, in this group there may have been a degree of attrition, thereby wearing down premature contacts and subsequently increasing the number of remaining tooth contacts. When considering the bruxism group, LOIS has been shown to be effective in discouraging parafunction, especially clenching and bruxism in CO, by deliberately increasing the load on the proprioceptive fibres of the periodontal membrane on the premolar or canine teeth and possibly preventing occlusal contacts between the posterior teeth in CO and also reducing the muscle force generated by the patient. The principle is based upon the theory that the smaller the area of contact the less the muscular activity. No significant change in occlusal contacts between first and final reviews was observed as indicated by Tables 1and 3.

DDçR Group,

This group received treatment with an ARPS as an occlusal appliance.

Tables 1 and 2 indicate no change between the review periods for this group. However, the number of occlusal contacts in this group is statistically significantly less than in the other 2 patient groups and the control group. This could be explained by the fact that the disc displacement alters the condyle/fossa relationship allowing upwards movement of the condyle on the affected side, thereby reducing occlusal contacts on the contra-lateral side.

The value of an ARPS in the treatment of DDçR is well established in the literature[26,27,28,29,30]. The aim of this splint was to direct the mandible into a protrusive position for a period of time. This directs the head of the condyle to move downwards and forwards causing a temporary restoration of the functional disc-condyle relationship. For this splint to be successful in treating DDçR, it should be worn on a 24 hour a day, basis for 3 months, followed by a controlled and gradual weaning off period. This protocol has been established elsewhere[29,30]. Since directing the mandible to this new anterior position for a period of time will temporarily alter the occlusal contacts, the final review was recorded at 3 months after weaning off the ARPS to allow a sufficient period of time for the mandible to regain its pre-treatment position. The long-term success rate of this splint has been demonstrated by Davies and Gray[30]. The authors showed that once a full "weaning off" period has relapsed, 90% who experienced improvement in clinical symptoms of disc displacement maintained improvement at 3 year follow up.

Tables 1 and 3 shows a significant change in the number of occlusal contacts between the first review and the final review in this group ($P<0.05$).

Direct comparison of the findings of our study with those of other studies is difficult. One of the possible reasons for this is the failure in defining the diagnosis of TMD examined in the previous studies. The majority of those studies used the non-specific generic term "TMD". Since there are a variety of disorders, some of which might be related to the occlusion and some not, "lumping" all types of disorders into a single category has been recognised as being a major flaw[31]. In the present study, this was avoided by correlating the occlusal findings individually with each specific TMD diagnosis. The significant increase in the number of occlusal contacts in DDçR between R1 and R3 in our study can be explained by the "orthopaedic stability" theory proposed by Bakke et al[32] and Okwson[23]. This theory is based on the concept of the importance of the "harmony" between the intercuspal position of teeth with the stable position of the condyles in the fossae. The absence of this "harmony" leads the condyle in one or both sides to be in unstable relationship with the disc and fossa. When the elevator muscles contract, this instability leads the condyle on the affected side to move superiorly, seeking a more stable relationship with the disc and fossa. In addition to the intra-capsular disorder, that is the disc displacement, resulting from this movement, this might lead to a decrease in occlusal contacts as a result of upward displacement of the condyle with the possibility of new occlusal interferences coming into function and further aggravating the condition. This view was originally postulated by Juniper[2] who suggested that following any displacement of the TMJ disc, the condyle also becomes displaced and the relationship of the lower teeth to the upper teeth changes resulting in premature contacts. Moreover, Klineberg and Jagger[33] hypothesised that in some individuals heavy bite forces or parafunction create a lever arm with the interference as the fulcrum leading to a possible compression of the ipsilateral TMJ and may cause a TMD in that joint.

CONCLUSION

The clinical implications of the findings are very important not only in relation to patients suffering from signs and symptoms of a TMD but also in relation to patients undergoing restorative treatment. The important finding is that when the disc is out of place the occlusion will change. This, however, does not appear to be a diurnal variation. If the disc is out of position then the number of occlusal contacts appears to be reduced. It would therefore appear to be sound advice not to make permanent and irreversible adjustment to the occlusion in the presence of disc displacement as when the disc repositioned occlusal contacts will change.

MANUFACTURERS' DETAILS

- Occlusal Sketch (Davis, Schottlander and Davis Ltd, Hertfordshire, UK)

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