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Effect Of Occlusal Splints At Different Vertical Dimensions On The Condylar Position and Muscle Activity In Worn Out Dentition - An In Vivo Study

Research Article

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Abstract

Objective: Vertical dimension must be increased gradually in patients undergoing full mouth restorative therapy and any adverse symptoms during the process must be monitored. Occlusal splints are the best way to increase the vertical dimension in a patient. The present study is aimed to analyse the effect of different splints on the condylar position, verical dimension and EMG activity of masseter and anterior temporalis.

Methodology: Patients with moderate to severe attrition were included in this randomized cross over study and were constituted into four groups (n=10). Canine to canine splint and full arch splint at both 1 mm (Group A, C) and 4mm (Group B, D) vertical dimension were made. The surface EMG activity of anterior temporalis and masseter muscle and Lateral cephalograms for condylar position assesmentwere recorded bilaterally pre and postoperatively after the insertion of the splints.

Results: The mean EMG values (μV) Masseter reduced from 263.10±24.7 to 147.15 ±12.77μV with the use of canine to canine 1mm splint , 134.7 ±14.72μV with the use of canine to canine 4mm splint, 145.47 ±26.86μV with the use of full arch 1mm splint, 139.04 ±28.21μV with the use of full arch 4mm splint. with a statistical significance ($p<.001$). Condylar position did not show a significant statistical difference ($p>0.05$).

Conclusion: The occlusal splints were effective in reducing the masticatory muscle hyperactivity. The reduction in muscle activity was more at increased vertical dimension of 4mm when compared to 1mm splint. The splints were similar in positioning the condyles.

Keywords: Centric Relation; Occlusal Splints; Vertical Dimension; Electromyography.

Introduction

The gradual wear of the occlusal surfaces of teeth is a normal physiologic process during the lifetime of a patient [1]. Mechanical factors such as type of contact between the teeth, occlusal forces, duration of contact and the presence of abrasive factors in the oral cavity are the main cause of occlusal wear [2]. The occlusal wear in the anterior teeth result in loss of anterior guidance and causes severe wear of posterior teeth resulting in loss of vertical dimension [3, 4].

Reduced vertical dimension needs to be restored in patients undergoing full mouth restorative therapy through various measures of increasing vertical dimension. The vertical dimension has to be increased gradually and the patient has to be monitored for any adverse symptoms during the process. Loss of vertical dimension affects the facial aesthetics, phonetics and also the neuromuscular physiology. When the individual with loss of vertical dimension clenches, the condyle is forced upward and backwards in the glenoid fossa and the muscles of mastication are in a contracted state resulting in severe hyperactivity of the involved muscles [5]. This detrimental effect needs to be reversed to regain the health of the stomatognathic system. Occlusal splints are the best way to increase the vertical dimension in a patient, as the effect can be reversed.

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During full mouth rehabilitation of patients with loss of vertical dimension, the aetiology, correct sequence of treatment and establishing the correct maxillo-mandibular relationship before planning the treatment is important in determining the best treatment option for patients. Centric relation must be used as the functional position as it is repeatable and elevator muscles show minimal or no discomfort as the condyle disk assembly is properly aligned [6]. Use of an occlusal splint helps in deprogramming the muscle engrams and helps in positioning the condyle in centric relation position as well as a treatment planning tool by assisting in checking the compatibility of the new vertical dimension [7].

Evaluating whether guiding the mandible has actually established centric relation position is difficult. Previous studies discuss the use of Electromyography (EMG) to assess the effectiveness of occlusal splints in reducing the activity of the muscles of mastication commonly masseter and temporalis as well as reduction of symptoms in muscular disorders [8, 9]. Radiographic assessment of the Temporomandibular joint was done in patients with skeletal malocclusions and Temporomandibular joint disorders but not with loss of facial height or with occlusal attrition [10].

The relation between the condyle position and the muscle activity was not elaborately discussed previously. Hence the present study aims to determine the effect of difference in condyle position achieved using splints on the activity of temporalis and masseter.

Materials and Methods

Subjects Included In The Study: Patients visiting Department of Prosthodontics in Saveetha Dental College were screened for generalised moderate to severe occlusal wear in both upper and lower arches. Based on the inclusion and exclusion criteria 35 such individuals were identified. On further evaluation 17 such screened patients had matched with all the below said criteria. Out of them 10 patients agreed to participate in the study.

Inclusion criteria were Patients with attrited dentition, Patients with loss of vertical dimension >3mm. Exclusion criteria were Attrited dentition without posterior occlusal contacts, Attrited dentition with anterior missing teeth, Allergy to the electrode or contact material (tape/gel), Patients with pacemakers.

Patients were explained that a radiograph and surface EMG would be performed at every visit. They were informed that surface EMG is used as a diagnostic tool for neuromuscular effects and Lateral cephalograms were used for routine dental examination and that both did not have any detrimental effects. Informed consent was obtained prior to commencement of the treatment.

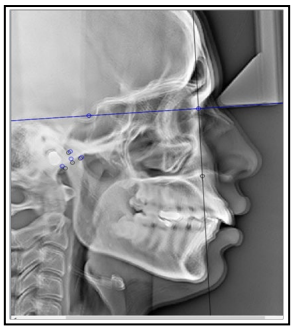
The study performed was a cross over trial. The patients were categorized in to Group A: Intervention with Canine to canine splint 1mm Group B: Intervention with Canine to canine splint 4mm (Figure 1) Group C: Intervention with Full arch splint 1mm Group D: Intervention with Full arch splint 4mm. (Figure 2) with a cross over transition. The EMG activity of anterior temporalis and masseter muscle was recorded bilaterally. The recordings were made after one week of wearing the splint. Lateral cephalograms were also made during the visits. After the recordings were made a wash over period of one week was given for muscle deprogramming before the next splint was given. Additional period for wash out was not given, as the included subjects were devoid of active temporomandibular joint disease.

Figure 1. Canine to canine 4 mm splint.

Figure 2. Full Arch 4mm Splint.

Figure 3. EMG recording of right temporalis.

Figure 4. Superimposition of lateral cephalograms.



Fabrication Of The Splint: Niswongers physiological method was used to determine the loss of vertical dimension. The maxillary cast was mounted with the face-bow transfer and the mandibular cast mounted with the interocclusal record in semi adjustable articulator. Splints were made with clear autopolymerising acrylic resin. Splints made were canine to canine splint and full arch splint at both 1mm and 4mm vertical dimension. The patients were allocated the splints to be worn. The splint was worn for a period of one week following which the surface EMG recordings and lateral cephalograms were made. A wash over period of 1 week was given following which next splint was given.

Surface EMG Recordings: Bilateral Surface EMG recordings of masseter and anterior temporalis were made during the visits (Fig 3). Scorpio EMG (Allengers, India) was used and the recordings were made during maximum volatile clenching (mvc) for a duration of 1 minute. The peak to peak amplitude was recorded in micro voltage (μV). The sensitivity of the instrument was set at 100 micro voltage for every recording to ensure noise elimination.

Lateral Cephalogram Analysis: Lateral cephalograms were made before the treatment and also after a week of wearing each splint. The cephalograms were analysed using Facad® (IlexisAB, Sweden) cephalometric analysis software. Four landmarks were marked in the condyle Dc, Co, Ar and an anterior point created 5 mm anterior to Dc. The sella S, Nasion and anterior nasal spine were used as references for superimposition (fig 4). In the superimposition the amount of change in condyle position is measured The position of condyle in each cephalogram is measured using a method described by Pullinger and Hollander (1987) for evaluating the concentricity of the condyle in glenoid fossa. The anterior and posterior linear joint space were measured and condyle displacement is expressed as CD=(A-P/A+P)100. -12%to +12% represents basically centric condyle position.

Results

The values obtained were tabulated and analysed using paired t test for statistical analysis by SPSS software version 20. For non-parametric values Wilcoxon signed ranks test was used to compare the condylar position before and after splint therapy The primary outcomes evaluated are the Surface EMG values in μVof Masseter and temporalis on each side.

The mean EMG values of Left Masseter reduced from 263.10 ±24.70 to 147.15 ±12.77 μV with the use of canine to canine 1mm splint, 134.77 ±14.74 μV with the use of canine to canine 4mm splint, 145.47 ±26.87 μV with the use of full arch 1mm splint, 139.04 ±28.21μV with the use of full arch 4mm splint. The mean EMG values of Right Masseter reduced from 273.75 ±67.75 to 139.13 ±13.69 μV with the use of canine to canine 1mm splint, 130.31 ±17.83 μV with the use of canine to canine 4mm splint, 146.17 ±21.44 μV with the use of full arch 1mm splint, 138.85±15.52μV with the use of full arch 4mm splint.

The mean EMG values of Left Temporalis reduced from 142.05±22.64 to 112.93 ±15.27μV with the use of canine to canine 1mm splint, 130.31 ±17.83μV with the use of canine to canine 4mm splint, 100.36 ±21.45μV with the use of full arch 1mm splint, 95.01±20.44μV with the use of full arch 4mm splint.

The mean EMG values of Right Temporalis reduced from 121.14±11.41 to 104.37 ±14.74μV with the use of canine to canine 1mm splint, 93.61 ±13.217μV with the use of canine to canine 4mm splint, 103.93 ±19.10μV with the use of full arch 1mm splint, 97.80±13.65μV with the use of full arch 4mm splint.

The values were subjected to statistical analysis, SPSS software version 20, paired t test. There was significance statistically in all the four groups with p values <0.001.

The secondary outcome evaluated was the position of the condyle. Wilcoxon signed ranks test was performed for the non-parametric values. There was no significance statistically in canine to canine 1mm, 4 mm and Full arch 4mm with p values 0.143, 0.172, 0.102 and 0.215 respectively.

Discussion

The present study is aimed at knowing whether different splints have varied effects on the condylar position and EMG activity of the masseter and anterior temporalis. There are several types of occlusal splints and designs described in the literature but they differ in their therapeutic outcome [11].

Intercuspation is necessary for maintaining the correct maxillomandibular relation. Changes in the occlusal anatomy cause the teeth to assume a new position of equilibrium. Attrition is the important cause for the change in occlusal anatomy and is a sign of functional wear, skeletal malocclusion and bruxism [12]. Tooth wear results in compromised aesthetics and reduction in vertical dimension, which can result in collapse of facial height. The loss of clinical crown height makes the condyle to assume a more pathological position which in the long run might result in temporomandibular joint diseases and it becomes difficult to re-establish the vertical dimension [13]. The changes in occlusion or occlusal wear pattern can affect the condylar position/movement,

the path of mandibular closure, and the sequence of timing of mandibular movement in the chewing cycle [14].

In patients with loss of vertical dimension the muscles are in a constantly contracted state. This might result in muscle spasm and pain. The use of occlusal splints results in decrease of pain and muscular spasm caused by hyperactivity of elevator muscles in subjects with temporomandibular joint disorder. In the present study there is a statistically significant decrease in muscle activity of the anterior temporalis as well as masseter with the use of occlusal splints irrespective of the design.

The left masseter experienced a maximum decrease of 48.77%, the right masseter of 52.39% and the right temporalis of 22.72 % in the activity with canine to canine 4 mm splint. The left temporalis muscle experienced a decrease of 33.11% with full arch 4mm splint. This might be due to the fact that temporalis is responsible for elevation and retraction of the mandible where as the masseter muscle is responsible only for elevation of the mandible. There are incidences when the activity of temporalis muscle has increased or found to be higher than the masseter following splint therapy in sleep bruxers [15, 16].

In the present study with the use of 4mm splints both canine to canine and Full arch splint design, maximum reduction in muscle activity was observed. A few other studies also had a similar effect of reduction in muscle activity with increase in vertical dimension was observed. However with the use of 8mm occlusal splint, it was reported that there was decrease in muscle activity initially and a subsequent increase in the muscle activity. This was also an indicator for any abnormal increase in facial vertical height beyond normal physiological limit gives a transient decrease in muscle activity [17, 18].

It has been stated that only when posterior dis-occlusion is obtained by an appropriate anterior guidance, the elevating activity of the temporal and masseter muscles be reduced [19]. It is not the contact of the canines that decreases the activity of the elevator muscles, but the elimination of posterior contacts [20].

Christensen in his study increased the vertical dimension by a posterior bite plane and both subjective and clinical findings indicators like tenderness, pain reported to be more severe [21]. Where as in some of the other studies, the patients had discomfort wearing a splint initially for a day but later the sense of discomfort gradually got reduced during the treatment. In the present study either of the two splint's increase in height did not cause any tenderness or pain and 80% of the patients were more comfortable with full arch splint when compared to canine to canine splint [22, 23].

Studies were conducted in the direction of skeletal malocclusions and condyle positions in cases of temporomandibular joint disorder, but none of them had correlations to the change of vertical dimension or muscle activity [22-26]. In the present study, FACAD orthodontic tracing software was employed for determining the position of the condyle simultaneously with each splints correlating to its muscle activity giving a comprehensive output for the specific intervention.

The position of condyle in each cephalogram is measured using a method described by Pullinger and Hollander for evaluating the concentricity of the condyle in glenoid fossa [27]. Cephalometric tracing with FACAD is highly correlated in terms of reliability and reproducibility of the measurements [28]. The splints were effective in guiding the mandible to centric relation position at an increased vertical dimension. The use of splints provide a more physiological muscle engram than what exists before the splint therapy guiding the patient to centric relation easier [29].

Conclusion

The occlusal splints were effective in reducing the masticatory muscle activity.

The reduction in muscle activity was more in masseter muscle when compared to Temporalis muscle with occlusal splint therapy. The reduction in muscle activity was more at increased vertical dimension of 4mm when compared to 1mm splint. The splints were similar in positioning the condyles. Condylar position did not show any variation with respect to all the splints used in this study.

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