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ORIGINAL ARTICLE

A Comparison of the Change in Mandibular Condyle/Fossa Relationship with the Use of Anatomic Teeth and Semi-anatomic Teeth in Complete Denture Prosthesis

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Abstract The association between dental occlusion and mandibular condyle/fossa relation has long been debated and still remains one of the most controversial issues in Prosthodontics. The aim of the study was to evaluate the effect of two different tooth forms on the condyle/fossa relation recorded during jaw relation process. Twenty edentulous patients were selected with good neuromuscular control. For each patient two pairs of dentures were fabricated with anatomic teeth and semi-anatomic teeth. Condylar position was recorded using a digital volume tomography (DVT) following the process of jaw relation (following extra oral tracing). Subsequent laboratory remounting, the denture insertion was done and DVTs were taken again for both the dentures separately. Two methods were used to evaluate the condyle/fossa relation viz. (1) Zhang's method (2) Brewka's method. The obtained values were then subjected to statistical analysis. The statistical significance was set as at 0.05 %. The mandibular concentricity were analysed during the process of jaw relation and after the insertion of dentures with the two different tooth forms. Statistical analysis indicated that no statistically significant difference of the influence of different posterior tooth forms on the condyle/fossa relation recorded during jaw relation ($p < 0.05$). Thus within limitations of this study it was concluded that the condyle/fossa relation established during jaw relation does not change with the change in posterior tooth form used.

Keywords Mandibular condyle · Temporomandibular joint anatomy · Posterior tooth forms

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Introduction

A basic knowledge of the stomatognathic system starts with the temporomandibular joint, since it is the centre of structural and functional inter-relationship. If one were to ask the one arch to arch relationship that is most important to comfort, function and health of stomatognathic system, one would definitely say without reservation, centric relation. It is impossible for one to develop a harmonious occlusal relationship without first determining that each condyle is properly aligned with its disk and the condyle-disk assembly is properly positioned in its fossa in centric relation. This is the starting point of occlusion [1].

It has always been a matter of controversy for years as to why artificial posterior teeth should resemble natural teeth. Gysi [2] recognized that his anatomic teeth would not satisfy all ridge relationships and in 1927 he designed a modified "cross bite" posterior teeth. In this scheme, the maxillary buccal cusps were almost eliminated resulting in one prominent lingual cusp that occluded into a lower anatomic tooth. These were the earliest semi-anatomic tooth forms. This innovative departure from contemporary occlusal forms created a great controversy and touched off a trend to alter occlusal forms for masticatory efficiency, balance, or to reduce thrust.

The influence of condylar position and the loss of posterior teeth on TMDs remains one of the most debatable issues, as does the influence of lost molar replacement by a removable denture. Nevertheless, some researchers have shown the importance of prosthetic rehabilitation for reducing the symptoms of TMDs [3].

Digital volume tomography (DVT) is a recent imaging technique which produces similar three dimensional images to CT but at a radiation dose comparable with panoramic radiography and a lower expense. DVT provides us

with the option of skull imaging with high geometric accuracy in all spatial planes as well as three-dimensional reconstruction at high resolution. Until now, these options were only been available with standard CT. Although because of these recent developments it is possible with low-dose techniques to achieve a dose reduction of 76 % without losing diagnostic accuracy along with being ten times more than the effective dose of a panoramic radiograph [4, 5].

In fact compelling data explaining the relation of different types of posterior teeth on the condyle/fossa relation recorded during jaw relation is not presently available. The purpose of this study was to determine whether condyle/fossa relation gets altered when two different occlusal forms are used in a prosthodontic rehabilitation of a complete denture patient using DVT.

Materials and Methods

The study group of twenty edentulous subjects were selected (14 men, 6 women) with good neuromuscular control in the age group of 40–55 years. Since this study involved radiation exposure to the involved subjects, a written consent was obtained from each patient after full explanation of the procedure. All the subjects were examined by a same examiner. All the subjects were given a Research Diagnostic Criteria [6, 7] for TMD Questionnaire. The scores were carefully evaluated and the patients with the signs and symptoms of TMD were excluded from the study. The inclusion criteria for the study involved subjects with no history of TMD and subjects with well rounded upper and lower ridges. The exclusion criteria were temporomandibular joint pain verified by the questionnaire and clinical examination, previous treatment for TMD, or a history of psychiatric disorders or symptoms related to disease in other components of the stomatognathic system. Ethical clearance for this study was obtained from the ethical clearance committee of S.D.M College of dental sciences (ID no-2013/P/PROS/22). It would also be mentioned that this study was conducted in accordance to the principles of the Declaration of Helsinki as revised in 2000.

The DVT's of the subjects were recorded with the assigned radiologist of the institution. In order to eliminate observer's bias, the radiologist was informed to randomize the soft copies of the DVT of the dentures with anatomic teeth and DVT of the dentures with semi-anatomic teeth and to hide the information regarding the type of denture they were wearing from the observer. All the radiographic tracings were performed by the same clinician.

Routine steps were performed till final impression to get the master casts. The master casts were then duplicated using liquid silicone (Doublident, Hamburg, Germany). Wax rims were fabricated on the temporary denture base. Tentative jaw relations were recorded and centric relation was recorded. The terminal hinge axis was recorded using Hanau spring bow. The maxillary and mandibular casts were mounted on to the Hanau wide view articulator. Extra oral gothic arc tracers were attached to the maxillary and mandibular occlusal rims. Extra oral tracing was carried out and centric relation was confirmed. A digital tomogram was then taken during this stage to have a radiographic record of the centric relation. The casts were then remounted according to the correct centric relation. The occlusal rims were then rebuilt. A silicone putty index (Aquasil, Dentsply, Konstanz, Germany) was then made on these rims. A second set of rims were then duplicated using this index. The articulator was then programmed according to values derived from the patients protrusive bite record. Thecondylar guidance was adjusted until the protrusive record was completely seated. The Bennett angle was calculated using the Hanau formula L = H/8+12.

Preparation of Dentures with Anatomic Teeth

After the rims were duplicated, a teeth arrangement was done in class 1 arrangement using anatomic teeth with a cusp angle of 33° Cosmo teeth set (Cosmo, Dentsply, Tianjin, China). Uniform contacts were then in centric relation established. Waxing and carving procedures were carried out. Denture was then tried in the patient's mouth. After a satisfactory trial procedure, the trial dentures were then processed. Laboratory remounting was done following BULL's law. Uniform contacts were established both in centric and eccentric positions. The dentures were then inserted and minor adjustments were done. A digital volume tomogram of the two mandibular condyles was then taken during this step. It was then compared with the earlier DVT of the centric record.

Preparation of Dentures with Semi-anatomic Teeth

The other set of master casts and occlusal rims were used to fabricate this set of dentures. Teeth arrangement was carried out with the help of semi-anatomic teeth (Premadent, Delhi, India).The teeth were arranged in class 1 arrangement. Selective grinding was performed. After the insertion of these dentures a DVT of both the mandibular condyles were carried. These were then compared with the DVT of the centric record.

Measurement of the Change in Condyle/Fossa Relation

A Kodak Digital Volumetric Tomogram was used for this study. A total of six DVT's were recorded for a patient.

Initial two DVT of the right and left condyles were taken during the jaw relation step. The other set of DVT was taken during the insertion of the dentures with anatomic teeth and the final set of DVT was taken during the insertion of the dentures with semi anatomic. For measurement of the joint space between the condyle and the glenoid fossa the method suggested by Zhang Zhenkang [8] was used (Fig. 1). Accordingly a reference line was drawn parallel with the Frankfort horizontal plane and tangent to the superior most aspect of the glenoid fossa. From the highest point of the glenoid fossa, line A was drawn perpendicular to the reference line. Line B was drawn at an angle of 45° to the line across the thinnest part of the joint. Line C was also drawn at 45° to the reference line passing through lines A and B. Line C also passes through the posterior joint space. The length of lines A, B and C between the condyle and the glenoid fossa were calculated and denoted the width of the upper anterior, superior and posterior joint spaces [6]. The centre of the condyle and the centre of the fossa were located according to method described by Brewka [9], Willis [10], and Hatjigiorgis [11] (Fig. 2). Line 1 was drawn parallel to the reference line and tangent to the highest point of the condyle. Line 2 perpendicular to line 1 and tangent to the anterior most aspect of the condyle. Line 3 was drawn parallel to line 2 and tangent to the posterior most aspect of the condyle. Line 4 was drawn parallel to line 1 and at a distance to line 1 equal to that between line 2 and line 3. These four lines intersect to form a square. The intersection point of the two diagonals of this square denoted the centre of the mandibular condyle. Line E–F was drawn parallel to the reference line and tangential to the crest of the articular eminence. The line representing the X-axis was drawn further midway between and parallel to line E–F and the reference line. The line perpendicular to the reference line at the point where the reference line intersected the height of the fossa represented the Y-axis. The point of intersection of the X- and Y-axes indicated the centre of the glenoid fossa. The distance from the centre of the condyle to the center of the glenoid fossa on the X-axis and the Y-axis was measured and recorded.

Results

The statistical unpaired *t* test was performed. The obtained values compared were independent variables. The unpaired *t* test showed no statistical difference (at the 5 % level) between the values obtained from comparing the condyle/fossa relation during jaw relation and during insertion of dentures with anatomic teeth. The results are displayed in graphic presentation (Figs. 3, 4, 5 and 6). In addition the data obtained in this by comparing the condyle/fossa relation during jaw relation and following insertion of dentures with semi-anatomic teeth, found that no statistical difference existed at 5 % level of significance (Figs. 7, 8, 9 and 10).

Discussion

Dawson [1] stated that the combination of anterior guidance and condylar guidance determines the border path of each mandibular posterior tooth. Rugh and Johnson [12] stated that movements of the mandible were determined by the shape, relative position and anatomy of the teeth and the temporomandibular joint. They emphasized that the relationship of jaw movements to occlusal and joint anatomy was a very important clinical factor. Blanchard [13] advocated that there are two factors governing the unavoidable length of the cusps they are; (1) The inclinations of the paths of the heads of the condyles in function, (2) Varying angle of incisal guidance deemed necessary for pleasing esthetics. Steep condylar and incisal inclinations force the use of sharper angles in the central fossae of posterior teeth, which result in creation of longer points on the occlusal surfaces of the teeth when they are formed to harmonize in functional movements of the lower jaw.

However the shallow inclinations in either or both of the incisal guidance and condylar paths tend to reduce the need for cuspal height, which, if excessive, results in heavy lateral thrusts that result in tilting of the dentures or overload the portions of the ridges by throwing unbalanced pressure into limited areas.

Dawson [14] stated that anyone who has recorded the hinge axis using a facebow should understand that it is possible to manipulate the mandible in centric relation and the mandible would rotate around a fixed axis without translation. The fact that the mandible can rotate around a fixed axis rules out vertical dimension as a critical aspect of centric relation. On the fixed axis of centric relation the condyles tend to rotate, enabling the mandible to close and open a fair amount without moving off the axis. Thus in this study because of recording the hinge axis with the face bow the position of the condyle with respect to the glenoid fossa does not change when two different teeth sets with different cuspal angles are used.

This study also substantiates the hypothesis that in centric relation the condyles are placed anterio-superiorly in the glenoid fossae and braced against the TMJ ligament and posterior surface of the eminence as is evident by the DVTs of the condyles in the centric relation.

Armani et al. [3] conducted a study to analyse the condyle/fossa relationship before and after prosthetic rehabilitation with maxillary complete denture and mandibular removable partial denture. He concluded that

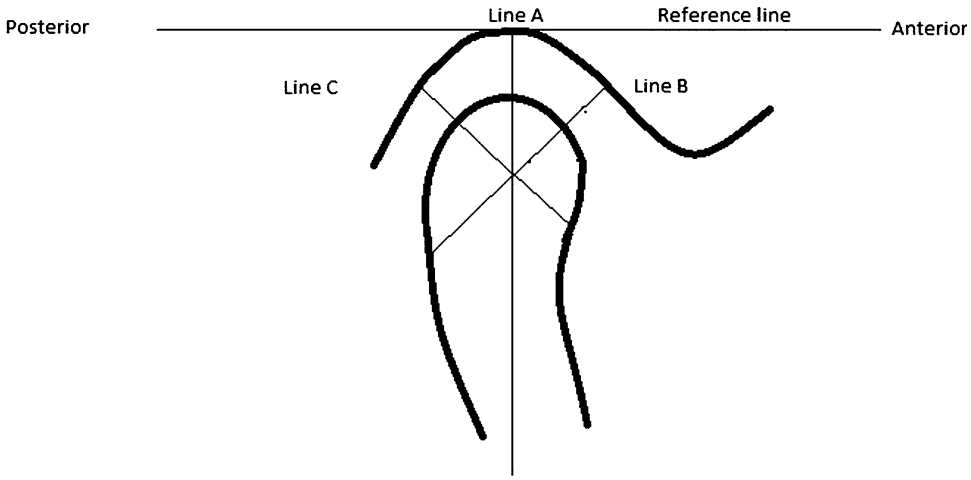

Fig. 1 Calculating the joint spaces with the Zhang's method

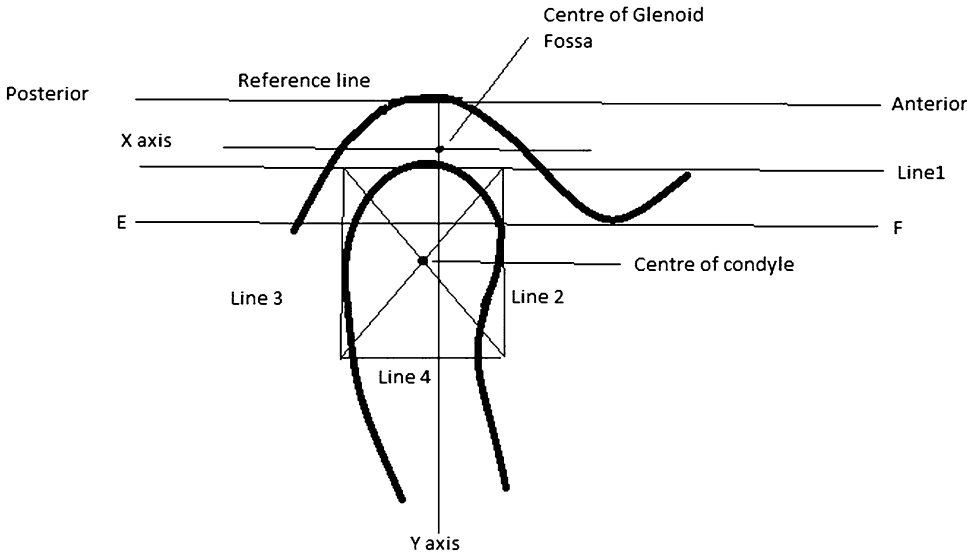

Fig. 2 Locating the centre of the condyle and centre of mandibular fossa using the method suggested by Brewka, Willis and Hatjigiorgis

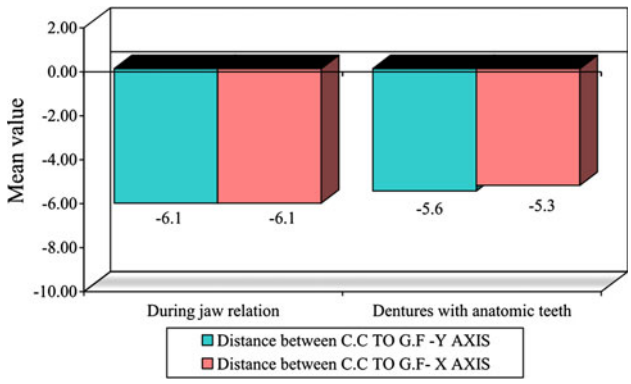

Fig. 3 Comparison of condyle/fossa relation during jaw relation and with dentures with anatomic teeth of the left TMJ using Brewka, Willis and Hatjigiorgis's method

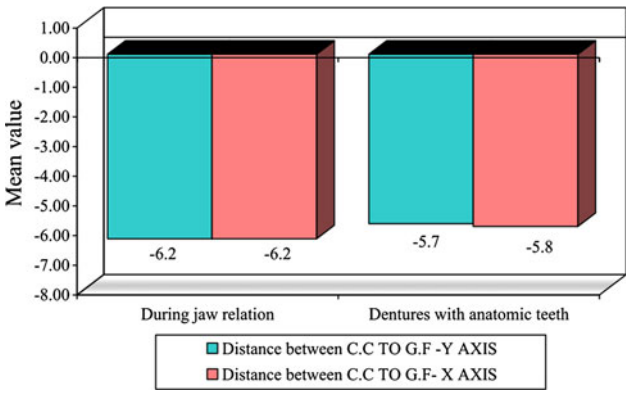

Fig. 4 Comparison of condyle/fossa relation during jaw relation and with dentures with anatomic teeth of the right TMJ using Brewka, Willis and Hatjigiorgis's method

significant changes in the condylar position occurred after prosthetic rehabilitation in subjects without symptoms of TMDs.

Alsawaf et al. [15] conducted a study to determine the influence of tooth contact on the path of condylar movements. The result of this study indicated that dynamic

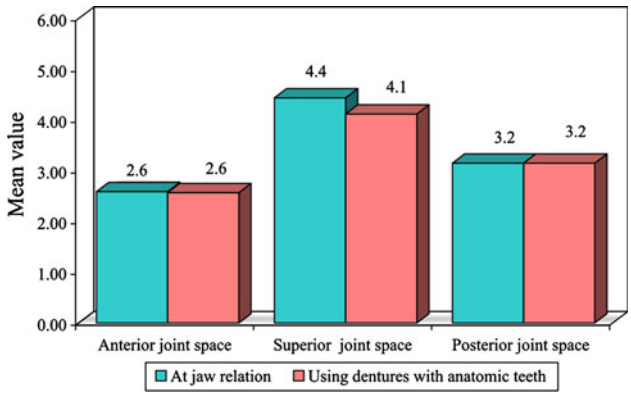

Fig. 5 Comparison of condyle/fossa relation during jaw relation and with dentures with anatomic teeth of the left TMJ using Zhangs method

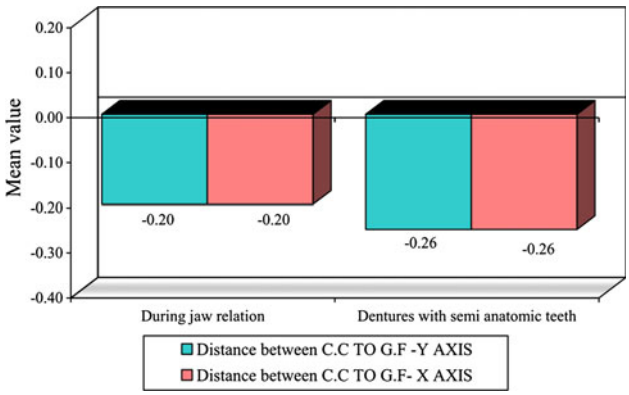

Fig. 8 Comparison of condyle/fossa relation during jaw relation and with dentures with semi-anatomic teeth of the right TMJ using Brewka,Willis and Hatjigiorgis's method

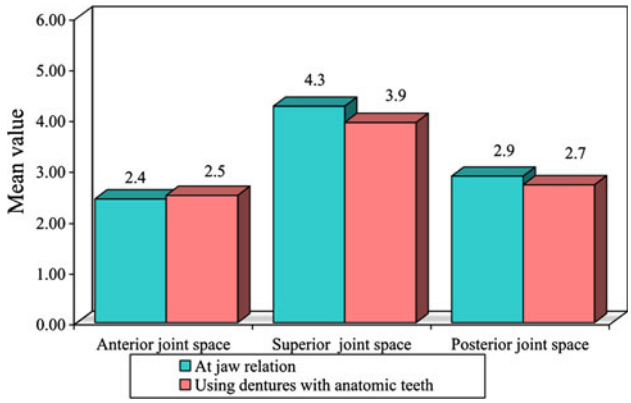

Fig. 6 Comparison of condyle/fossa relation during jaw relation and with dentures with anatomic teeth of the right TMJ using Zhangs method

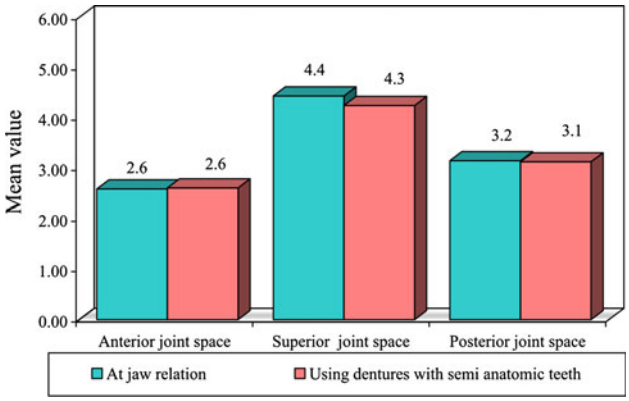

Fig. 9 Comparison of condyle/fossa relation during jaw relation and with dentures with semi-anatomic teeth of the left TMJ using Zhang's method

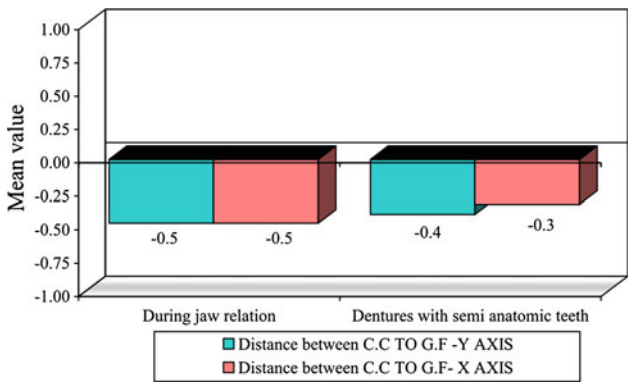

Fig. 7 Comparison of condyle/fossa relation during jaw relation and with dentures with semi-anatomic teeth of the left TMJ using Brewka, Willis and Hatjigiorgis's method

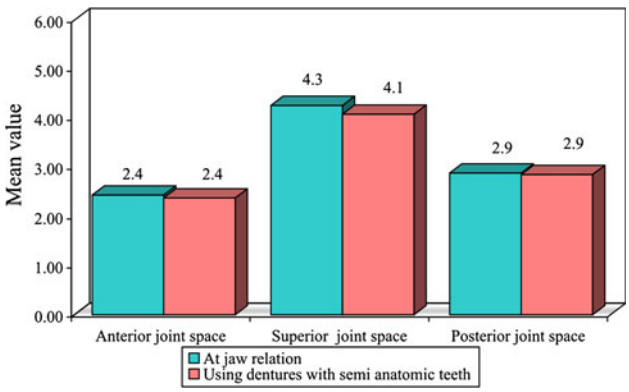

Fig. 10 Comparison of condyle/fossa relation during jaw relation and with dentures with semi-anatomic teeth of the right TMJ using Zhang's method

inter-arch tooth guidance or change in vertical dimension reflect a significant alteration in the recordings of condylar guidance.

The study had some limitations such as it did not include different occlusal patterns in the same denture base [16]. Since the sample size for this study was small (20 subjects),

future studies can be performed on this topic with larger sample size.

Also the study does not evaluate the role of different occlusal tooth forms on the condyle/fossa relations in different eccentric positions. Therefore, the further scope of this research is to evaluate the effect of two different tooth forms on the condyle/fossa relation in various eccentric positions and to perform a similar study on this topic with a larger sample size.

Conclusion

Thus, within limitations of this study the following conclusions were drawn:

1 The condyle/fossa relation recorded during jaw relation remained the same when dentures with anatomic teeth or dentures with semi-anatomic teeth were used and does not show any significant change between the two types of tooth forms.
2 The type of the tooth form used for processing dentures had no bearing on the condyle/fossa relation recorded during jaw relation procedure.

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