Original Article

Radiological examination of impact of edentulism on the articular eminence inclination using orthopantomogram

Chetan Modgi[1], Karishma Awari[2], Priyal Rajani[3], Jayant Palaskar[4], Prashant Jadhav[5], Vineet Vinay[6]

From, [1]Reader, Department of Prosthodontics, Yogita Dental College and Hospital, Khed, India, [2,3]Intern, [4]Professor and Head, [5]Reader, Department of Prosthodontics, [6]Lecturer, Department of Public Health Dentistry, Singhdad Dental College and Hospital, Pune, India.

Correspondence to: Dr. Chetan Modgi, Department of Prosthodontics, Yogita Dental College and Hospital, Khed, Maharashtra, India – 415709. Email ID: dr.chetanmodgi@gmail.com

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ABSTRACT

Background: Occlusion is an important component of the temporomandibular joint (TMJ). Little is known about the association between missing teeth and TMJ changes. The objective of this study was to compare inclination of the articular eminence (AE) between dentulous and edentulous arch. **Method:** A total of 500 patients were divided into group A (dentulous) and group B (edentulous). Group B was further divided into subgroups based on years of edentulism into group 1, group 2 and group 3. On patient's panoramic radiograph, the sagittal outline of the AE and glenoid fossa were traced, and a sagittal condylar path inclination was constructed by joining the crest of the glenoid fossa and the crest of AE. This was then related to the constructed Frankfurt's horizontal plane to determine the inclination of AE. **Results:** The mean measured value for the AE inclination was varying with all the groups. The mean and standard deviation value (combining right & left) for Group A was 42.8^{+}/-6.83 degrees, Group B was 30.45^{+}/-6.55degrees, Group 1 was 30.2^{+}/-7.23degrees, Group 2 was 31.2^{+}/-4.75 degrees, and Group 3 was 27.5^{+}/-9.3 degrees. Significant differences were found in AE inclination between the dentulous and edentulous groups ($P < 0.05$). **Conclusion:** A significant difference in the AE inclination was found between dentulous and edentulous groups as well as with increase in the period of edentulism.

Key words: *Condylar path inclination, panaromic radiographs, glenoid fossa, Frankfurt horizontal plane, edentulous arch.*

The temporomandibular joint (TMJ) is a complex articular system which is located between the mandible and the temporal bone. It achieves the mandibular functions with a dynamic balance mechanism and has the ability to move within the three planes of space. The glenoid fossa creates the superior bone part and the mandibular condylar process creates the inferior bone part of the joint. There is no doubt that the TMJ is one of the most complex joints of the body and its structure is further complicated by its close proximity to the dentition, muscles, and other oral structures. Because of this intimate relationship with the dentition, it is essential for dentists to have a sound understanding of the stomatognathic system [1]. The articular eminence (AE) is a part of the temporal bone on which the condylar process slides during mandibular movements. The inclination of the AE varies across the population and dictates the path of condylar movements as well as the degree of rotation of the disc over the condyle [1].

Many methods are used to examine the inclination of the articular eminence, such as measurements on dry skulls, conventional radiography and tomography,

Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) [2]. Orthopantomogram (OPG) allows easy tracing of the boundaries of joints along with calculation of slope of the articular eminence. Results from previous studies indicate that tooth wear and tooth loss cause deleterious effects at the TMJ such as resorption of the AE and may accelerate the development of degenerative joint diseases [1]. The observed changes in the AE may be used as predictors of temporomandibular problems. Hence, the present study was undertaken with an objective to compare the inclination of the articular eminence between dentulous and edentulous arch.

MATERIAL AND METHODS

The present study was carried out among the patients visiting Sinhgad Dental College and Hospital for dental treatment. After obtaining approval from the Scientific Advisory Committee and The Institutional Ethical committee, an informed consent was obtained from the participants who agreed to undergo the study. The patients who did not agree, continued their required general treatment. All the OPG images were taken on Planmeca Proline (180-240, 1500VA, 50 Hz). The sample size was determined using the following formula:

$$N_1 = \frac{(\sigma_1^2 + \sigma_2^2/k)(z_{1-\frac{\alpha}{2}} + z_{1-\beta})^2}{\Delta^2}$$

$$N_2 = \frac{(k * \sigma_1^2 + \sigma_2^2)(z_{1-\frac{\alpha}{2}} + z_{1-\beta})^2}{\Delta^2}$$

The notation for the formula are: N_1= sample size of group 1, N_2= sample size of group 2, σ_1 = standard deviation of group 1, σ_2 = standard deviation of group, Δ = difference in group means, k = ratio = n_2/n_1, $z_{1-\frac{\alpha}{2}}$ =Two sided Z value (e.g. Z= 1.96 for 95% confidence interval) and $z_{1-\beta}$ = power. Based on the formula a sample size of 500 was obtained with 50 patients in each group. Patients were categorized into Group A (dentulous) and Group B (edentulous) groups. Edentulous groups were further divided into group Group 1 (edentulous since 1 year), Group 2 (edentulous since 2 years), and Group 3 (edentulous since 3 years). These groups were further divided into right and left.

Patients above 40 years of age were included in the study. Edentulous patients who continued to wear dentures for up to three years after extraction, whose OPGs existed in the institutional records were included in the study. Patients with presence of set of 28 natural teeth were included in the dentulous group. Patients with temporomandibular joint dysfunction, congenital craniofacial abnormalities, systemic disease which may affect joint morphology (such as rheumatoid arthritis), fracture, pathologic lesions in the region of AE were excluded. All the OPG records were collected from the institutional records by the observer and measurements were made using Master View DICOM 4.5.3 Beta. The articular eminence guidance angle was measured using the points and planes, as described below.

The sagittal outlines of the left and right Articular Eminence (AE) and glenoid fossae were traced. The left and right 'orbitale' (the lowest point in the margin of the orbit) and the 'porion' (the highest point in the margin of the auditory meatus) were identified and the Frankfurt horizontal plane was constructed by joining the two landmarks on each side. The most superior point on the glenoid fossa (the crest of glenoid fossa) and the most inferior point on the AE (the crest of AE) were identified and a second line to represent the mean condylar path inclination (CPI) was constructed by joining the two points. Using these two planes, the AE inclination was drawn as an angle between the CPI plane and the Frankfort horizontal plane (Figure 1). Both right and left angle of condylar guidance (articular eminence) was measured for edentulous and dentulous OPGs.

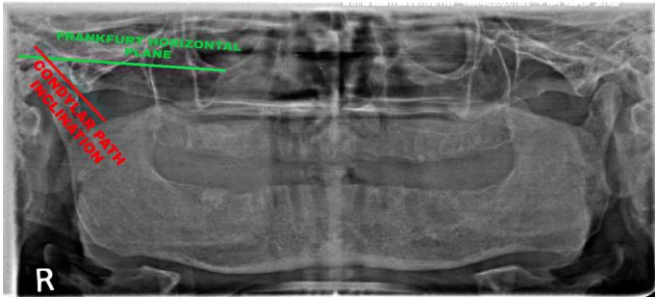

Figure 1: Articular eminence traced on the right TMJ on OPG of an edentulous patient

The Data obtained was entered in Microsoft Excel 10 and analysed using Statistical Packages for the social sciences (SPSS software -Version 21). Frequency analysis and Chi square test were used to measure the percentage and proportions. Paired t-test and ANOVA test were used for comparison and to determine statistical differences between experimental and control sides. The one-way analysis of variance (ANOVA) test was used to determine differences in the bilateral, mean, and the difference of AE inclination between side of edentulous group and between dentulous and edentulous groups. P-value of <0.05 was considered as a statistically significant.

Table 1: AE inclination of study groups

Dependent Variable		Group	Group	Std.Error	Sig.(P <0.05)
Angle of condylar guidance - Right	Bonferroni	Dentulous	Edentulous	1.26039*	.000
			Edentulous 1 year	1.09153*	.000
			Edentulous 2 year	1.26039*	.000
		Edentulous	Dentulous	1.26039*	.000
			Edentulous 1 year	1.09153	1.000
			Edentulous 2 year	1.26039	.064
		Edentulous 1 year	Dentulous	1.09153*	.000
			Edentulous	1.09153	1.000
			Edentulous 2 year	1.09153*	.010
		Edentulous 2 year	Dentulous	1.26039*	.000
			Edentulous	1.26039	.064
			Edentulous 1 year	1.09153*	.010
Angle of condylar guidance - Left	Bonferroni	Dentulous	Edentulous	1.15549*	.000
			Edentulous 1 year	1.00069*	.000
			Edentulous 2 year	1.15549*	.000
		Edentulous	Dentulous	1.15549*	.000
			Edentulous 1 year	1.00069	1.000
			Edentulous 2 year	1.15549	.125
		Edentulous 1 year	Dentulous	1.00069*	.000
			Edentulous	1.00069	1.000
			Edentulous 2 year	1.00069*	.015
		Edentulous 2 year	Dentulous	1.15549*	.000
			Edentulous	1.15549	.125

RESULTS

The mean measured value for the AE inclination was varying with all the groups. The mean value (combining right & left) for Group A was 42.8 degrees, Group B was 30.45 degrees, Group 1 was 30.2 degrees, Group 2 was 31.2 degrees, and Group 3 was 27.5 degrees with values ranging from 17 to 56 degrees. The standard deviation for Group A was 6.83 degrees, Group B was 6.55, Group 1 7.23, Group 2 was 4.75 and Group 3 was 9.3 with values. The AE inclination of the dentulous group was slightly higher than that of the edentulous groups, this difference was statistically significant (P<0.05). The left and right angle of condylar guidance did not show much variance with a standard deviation of less than 2 degrees, the difference was not statistically significant between the right and left angles within any of the dentulous or edentulous groups. However, significant difference was obtained between the following groups: Group A with Group B, Group A with Group 1, Group A with Group 2, Group A with Group 3, Group 1 with Group 2 and Group 1 with Group 3. (Table 1).

DISCUSSION

The AE is a small bone situated anterior to the glenoid fossa and its posterior surface slope varies in the population. Although it is an anatomical structure belonging to the cranium, it is exposed to functional load arising from chewing forces with other structures within the TMJ, and these loads influence its morphological shape [2, 3]. A previous study has indicated that loss of occlusal support is a causative factor for degenerative changes in the TMJs of female patients [4]. According to Katsavrias and Dibbets, with the completion of primary dentition, the articular eminence inclination develops approximately 45%, reaching 70–72% of its adult value around the age of 10 years and attains 90-94% development by the age of 20 years [5]. It is usually thought that morphological changes owing to function may occur in the eminence structure with advanced age and this situation results in the differentiation of bone contours and flattening of the eminence in the long term [6, 7]. In contrast, in some studies, no correlation was found between advanced age and eminence anatomy for either eminence height or

inclination [1, 8]. In the current study we have conducted a comparison between dentulous and edentulous groups with an age of above 40 years for both the groups. It was observed that the inclination angle went on decreasing with long term edentulism. There was a significant difference in the AE inclination between edentulism since 1 year, 2 years and 3 years respectively. Also a significant difference was observed between dentulous and edentulous groups of the same age as seen on table 1.

However, a biomechanical animal study may shed some light on this data using experimentally induced unilateral tooth loss. Huang et al demonstrated that unilateral mastication caused increased loading at the non-functional side of the TMJ [9]. Therefore, loss of unilateral posterior support maylead to compensatory remodelling of the missing part of the AE over time. In this study, the AE inclination on the left and right side had not shown any statistical significance. Also theory of the asymmetry of the AE inclination of the left and right joint, has been confirmed by previous studies [10, 11] where the symmetry equality ranged from 5.1% to 12%, The difference between the left and the right joint is probably caused by the predominant usage of one side of the dental arches during chewing and consequent unequal distribution of biomechanical forces. Thus, different biomechanical conditions caused by aging and teeth loss may have some effect on remodelling and reshaping of the AE [2].

Conventional techniques are inadequate for TMJ imaging because of the anatomical complexity of this region such as the superimposition of the adjacent dense temporal bone. In particular, panoramic imaging and conventional tomography may yield disappointing results [1]. It has been suggested that if panoramic radiography is to be used for the initial radiographic examination of the TMJ, practitioners should be aware of the potential for shape distortion of the structure [12]. In the present study, in addition to our relatively smaller study population, we cannot exclude inaccuracy due to shape distortion. An appropriate method for accurate measurement of AE inclination such as cone beam computed tomography (CBCT) to measure angles and distances would be used for future studies. Furthermore, due to the limited information on patients' history such as the time since tooth loss, a longitudinal study is necessary to investigate whether the long-term effects of tooth loss has a different association with the AE inclination. It was reported that a steep slope of the articular eminence predisposes to certain disorders in the internal derangement [7, 13, 14]. Thus, a study is necessary with large study population including age and gender variations for a long duration of time along with the TMJ dysfunction or internal derangement disorders, associated due to varying AE inclinations.

CONCLUSION

Changes noted in the articular eminence is said to be a risk factor for the temporomandibular disorder. The present study was the first comparative study measuring the AE inclination between dentulous and edentulous arches. The study concludes that there is a significant association between AE with increase in the period of edentulism.

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