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EVALUATION OF EFFECT OF AGE AND DENTAL STATUS ON POSTERIOR SLOPE OF ARTICULAR EMINENCE OF TEMPOROMANDIBULAR JOINT: A COMPARATIVE RADIOGRAPHIC STUDY

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ABSTRACT:

Purpose of the study: It is documented that the posterior slope of the articular eminence of completely edentulous patients compared to patients with maintained occlusion shows significant flattening and also the flattening of the posterior slope of the articular eminence is to be considered a result of ageing. But very limited studies have been done to determine which has significantly greater effect age or edentulism on flattening of posterior slope of articular eminence and whether early prosthetic rehabilitation has any effect on the flattening of posterior slope of articular eminence.

Aim: To establish a possible correlation between flattening of the posterior slope of articular eminence with age and dental status of the patients. Also to analyze the effect of early prosthetic rehabilitation of edentulous patient on steepness of articular eminence.

Material and Method: Patients requiring OPG as part of their diagnostic procedure for treatment in the Manav Rachna Dental College, Faridabad were screened and selected for the study. Total of 100 patients took part in the investigation and were divided into 2 main groups which were further subdivided into 2 subgroups of 25 subjects each as per the selection criteria after taking an informed consent from them.

Result and Conclusion: Both age and dental status has significant effect on flattening of posterior slope of articular eminence. But complete loss of dentition has significantly greater effect on flattening of posterior slope of articular eminence as compared to age. Thus completely edentulous patients should get rehabilitated with dentures for their edentulous state as early as possible as complete dentures have a favorable protective effect on temporomandibular joint structures.

Keywords: Age, Edentulous, Temporomandibular Joint, Orthopantomograph, Articular eminence, Complete Denture

INTRODUCTION

An increasing elderly population along with increasing life expectancy is indicated according to the statistics worldwide. Provision of effective therapy for these patients, requires knowledge about the age related changes in the stomatognathic system and the possible consequences of complete edentulism. Deformation of the masticatory muscles and of the articular surfaces of the

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Temporomandibular joint (TMJ) with age, loss of dental status and function could lead to clinical signs and symptoms of Temporomandibular Joint Disorders (TMDs) such as joint pain, muscle pain, mouth-opening limitation, clicking and crepitation. [1]

The Temporomandibular Joint is the complex articular system between the temporal bone and the mandible. It is a bilateral diarthrodial, ginglymoid joint. They are formed by the articulation of the condylar process of the mandible and the intra-articular disk with the mandibular fossa of the squamous portion of the temporal bone. [2,3] The fossa, located at the inferior aspect of the squamous part of temporal bone, is composed of the glenoid fossa and articular eminence of the temporal bone. The articular eminence is a part of the temporal bone on which the condylar process slides during mandibular movements. The inclination of articular eminence varies among people and it dictates the path of condylar movement as well as the degree of rotation of the disc over the condyle. [4]

Flattening of the articular eminence occurs via alterations due to erosion, osteophyte formation, anterior disc displacement with reduction or anterior disc displacement without reduction. These transformations appear to represent an adaptation of the condyle, articular disc and the articular eminence to changes in loading, and complete edentulousness over a long period of time which may lead to several irreversible deformities (like the anatomical changes of the articular eminence of the Temporomandibular joint). [5]

An analogue of the condylar guidance on an articulator is considered to be a necessary requisite in prosthodontics. The degree of inclination of the articular eminence is of value as an aid in setting the condylar guidance in semiadjustable articulators. If the incline is too flat or too steep then, control of protrusive and lateral eccentric guidance and posterior disocclusion or the attainment of a completely balanced articulation may be adversely affected. [6]

There are several methods to determine the angulation of the posterior slope of the articular eminence. Some authors historically took anthropological measurements carried out on dry skulls, while others utilized latest medical imaging techniques. Clinically, the condylar inclination angle reveals the steepness or the flatness of the posterior slope of the articular eminence and is determined by the intraoral wax record or by extraoral tracing methods. On other hand, if a panoramic radiographic method is considered, some authors state that the distortions taking place during the imaging of the panoramic X-ray and the over-projection of different anatomical structures on the radiograph do not enable the determination of a completely precise angle on the orthopantomographic image (OPGs). However, recently it was concluded that

the panoramic radiographic image of the sagittal inclination of the articular eminence consistently replicated the eminence inclinations in the human skulls. [7]

It is documented that the posterior slope of the articular eminence of completely edentulous patients compared to patients with maintained occlusion shows significant flattening and also the flattening of the posterior slope of the articular eminence is to be considered a result of ageing. But very limited studies have been done to determine which has significantly greater effect age or edentulism on flattening of posterior slope of articular eminence and whether early prosthetic rehabilitation has any effect on the flattening of posterior slope of articular eminence.

The purpose of the present study was to establish a possible correlation between flattening of the posterior slope of articular eminence with age and dental status of the patients. Also to analyize the effect of early prosthetic rehabilitation of edentulous patient on steepness of articular eminence. The null hypothesis of this study was that there exists no correlation between flattening of the posterior slope of articular eminence with age and dental status of the patient. Also early prosthetic rehabilitation of edentulous patient has no effect on steepness of articular eminence.

MATERIALS AND METHODS

Patients requiring OPG as part of their diagnostic procedure for treatment in the department of Prosthodontics, Manav Rachna Dental College, Faridabad were screened and selected for the study as per the selection criteria after taking an informed consent from them. In the present study, 100 patients took part in the investigation and were divided into 2 main groups which were further subdivided into 2 subgroups of 25 subjects each.

A. Group A

I) 18- to 25-year-old patients with maintained occlusion

II) Patients over 50 years with maintained occlusion

B. Group B

III) Patients over 50 years, edentulous for more than 1 year and not wearing dentures

IV) Patients over 50 years, edentulous for more than 1 year and wearing dentures

The patients for the study were selected as per the following selection criteria;

Inclusion Criteria*:* Age of the patients (group I: 18-25years; group II,III and IV: above 50 years), for Group I and II- patients with maintained occlusion (either first molar relationship maintained or presence of at least 20 to 24 teeth with vertical stop), for group III- period of edentulism not less than 1 year and not wearing dentures, for group IV-

period of wearing denture after edentulism not less than 1 year.

Exclusion criteria: Patient who have previously undergone any orthognathic surgery, edentulism as a result of recent extraction of all tooth, patients with facial deformity, patients who have undergone/ undergoing orthodontic treatment, patients with degenerative disorders of TMJ like internal derangement, arthritis, bruxism , joint disorder, for Group IV: period between edentulism and start of denture wearing not more than 1 year

An oral examination was carried out for each subject and detailed case history was recorded, to confirm the inclusion criteria and to rule out the factors determining as exclusion criteria. The purpose and nature of the radiographic examination to be performed on subjects was explained adequately to all the subjects in their native language. A Participant Informed Consent Form (PICF) was provided to each participant before starting the procedure.

Panoramic radiographic images were recorded by the same operator with the same panoramic radiographic unit (VATECH Digital X-ray Imaging System PAX-400C) (Figure 1). In order to standardize the measured values of patients with different dental status, all radiographs were taken at 68 Kvp and 8mA with the same three-dimensional positioning of the patients. All patients were positioned according to the median sagittal plane, according to the Frankfort horizontal plane and according to the plane of the canine with three laser beam plane pointer and four-point headrests (Figure 2).

Parchment transparent tracing sheet of A4 size were attached to all Dental Panoramic Radiograph with matt finish transparent tape. Measurements were carried out on Dental Panoramic Radiograph as per study conducted by Csado K et al.[7]The angle of the posterior slope of the articular eminence relative to the Frankfort plane was measured on both sides on the OPG radiographic images.

To determine the Frankfort horizontal plane two landmarks were identified and joined on the tracing sheet corresponding to radiograph. Orbitale (Or) [8] - point midway between the lowest point on the inferior margin of the two orbits Porion (Po)[8] -the midpoint of the upper contour of the external auditory canal (Anatomic Porion) or a point midway between the top of the image of the left and right ear-rods of the cephalostat (Machine Porion).

To determine the position of the posterior slope of the articular eminence two methods were used; Method 1- *Best-fit line method*[5]**:** The best-fit plane of the posterior surface of articular eminence was traced on OPG relative to the Frankfort plane (Figure 3a). Method 2- *Top-roof line method*[5]**:** The deepest point of the mandibular fossa was connected with the highest point of the

articular eminence relative to the Frankfort plane (Figure 3b).

Then, the angle between the plotted slope and the Frankfort plane was measured using Set Square on both sides for all subjects (Figure 4-7).

RESULTS:

The data thus obtained was arranged systematically and the information was transferred onto a master chart which was prepared in Microsoft Excel (2010) for the purpose of data analysis. All statistical analysis and computations were performed using Statistical Package for Social Sciences (SPSS) version 18.0, IBM Inc.

Mean values and standard deviations (SD) were calculated for all the groups. In each group, angle values of 25 subjects were measured by both methods on both sides. Obtained data were subjected to Descriptive Analysis for the calculation of mean, standard deviation, standard error. To find the significance of study parameters, Oneway ANOVA test was used to compare the mean values between the four groups followed by Post- hoc test for group wise comparison. One sample t- test was used to test the deviation between Group A and Group B, Male and Female (Table 1) for both methods and for both sides. Pearson Correlation (Table 2) was carried out within each group between age and angle measured by both methods and on both sides. Paired T- test (Table 3) was used to test the deviation within group and overall between angles measured on left and right side for both methods. Paired T-test (Table 3) was also carried to test the deviation between method 1 and method 2 for both sides within group and overall. A p-value of ≤0.01 was considered to be statistically significant at 99% CI and ≤0.05 was considered to be statistically significant at 95% CI.

Comparing the mean angle values ± SD of each group for Method 1and 2 revealed, highest value for Group A (I); followed by Group A (II), Group B (IV) and lowest value for Group B (III). A p-value of ≤0.05 revealed significant deviation of observations from standard value in each group at 95% CI.

ANOVA test followed by Post Hoc test (Turkey HSD) revealed significant mean differences between Group 1 and 2, Group 2 and 3, Group 3 and 4 which were 4.16±0.45, 8.56±0.45, -4.08±0.45 (Left side); 4.44±0.47, 8.32±0.47, -3.92±0.47 (Right side) by Method 1 and 3.12±0.48, 8.6±0.48, -2.56±0.48 (Left side); 3.72±0.51, 8.52±0.51, -2.56±0.51 (Right side) by Method 2 respectively at 95% CI.

Pearson Correlation between flattening of articular eminence and age of the patient obtained by linear regression analysis revealed a negative trend within the group for both method and for both sides at p- value ≤0.05, thus values were statistically significant (2 tailed) at 95% CI.

One sample T test for Group A and Group B showed difference between

mean angles is highly significant at 99% confidence level for both sides and for both methods. Values were insignificant between both sexes for all groups on both sides and by both methods.

Results from Paired T test revealed insignificant difference between mean angles of left and right for each method within all groups and overall. Also Paired T test between the two methods showed highly significant difference between the mean angle values for left and right within each group and overall at 99% CI.

DISCUSSION :

The TMJ and its associated structures play an essential role in guiding mandibular motion and distributing stresses produced by everyday tasks, such as chewing, swallowing, and speaking. TMJ disorders (TMD) are a class of degenerative musculoskeletal conditions associated with morphological and functional deformities.[9] Temporomandibular disorders include abnormalities of the intraarticular discal position and/or structure as well as dysfunction of the associated musculature. [10]

Remodeling of the load bearing joints is an essential adaptation process needed for appropriate stress distribution and function. When the capacity for the joint to remodel has been exceeded, remodeling merges into osteoarthritis.[11,12] Characteristic osteoarthritic changes observed in the TMJ include alterations in shape and overall size of joint components, specifically, flattened fossa, less pronounced articular eminence, decreased condylar volume and thickened disc. [12] Signs and symptoms of Arthritic Changes in the TMJ include pain, limitation of mandibular movements: functional limitation and joint sounds. [13,14]

Pathophysiology of the degenerative changes results from dysfunctional articular remodeling which is due to (1) a decreased adaptive capacity of the articulating structures of the joint or (2) excessive or sustained physical stress to the TMJ articular structures that exceeds the normal adaptive capacity. There is multiple host-adaptive capacity factor, associated with the host's general condition which are:

Advancing Age

Honda K et al. (2005) [17] concluded from their study that the minimum thickness of the glenoid fossa of the TMJ is not significantly correlated with sex or age in patients 50 years of age and older. It only provides information regarding joint remodeling and function in the disease and non-disease states. Dilhan Elguy et al (2014)[18] on examining the relationship between articular eminence inclination, height, and thickness of the roof of the glenoid fossa (RGF) according to age concluded that the sagittal osteoarthritic changes may have an effect on RGF thickness by mechanical stimulation and changed stress distribution, but articular eminence inclination had no relation with age.

In the present study angle values of the patients were listed according to age for both methods, a linear regression analysis for each study group was made; results showed a negative trend in group I which became more apparent from group II to group III. A negative trend was also seen in group IV. All the values were statistically significant at 95% CI. Thus it could be stated that a correlation exists between age and flattening of posterior slope of articular eminence.

Similar association were reported by Oberg T. et al (1971)[19]; Foucart Michel Jean et al. (1998)[20]; Toure G, Duboucher C, Vacher C (2005)[21]; KE Alexiou, HC Stamatakis and K Tsiklakis (2009)[22]; Pontual Anjos ML dos. et al (2012)[23] who stated that prevalence of degenerative bone changes of articular surfaces is an age-related disease.

Occlusion

Widmalm E Sven et al. (1994)[24] concluded that disk displacement, perforation, disk deformation, and arthrosis seem to increase with age. Gender and loss of teeth do not seem to have an influence on the amount of morphologic changes in the TMJ at the end of life. Ejima K et al. (2014) [25] concluded that roof of glenoid fossa thickness is unaffected by the coronal condyle head morphology and the number of remaining teeth.

Pearson correlation coefficients followed by Post Hoc (Turkey HSD) test were obtained from the present study within each group according to the age of the patients, it was seen that the connection between ageing and the flattening of the eminence is present in every group however, it is a lot more evident in group III. At the same time, the difference in the correlation coefficients between group II and III is significantly much higher than between group I and II. This finding leads to the conclusion that tooth loss (loss of maintained occlusion) or complete loss of dentition results in greater degree of increased flattening of the posterior slope of the articular eminence than ageing in itself.

Results were thus congruent with Maria E. Itotz (1966)[26]; Helkimo M. (1976)[27]; Hinton J. Robert (1981) [28]; Kawashima T et al. (1997) [29]; Kinga Csado, Krisztina Marton and Peter Kivovics. (2012) [30]; Lamia H. Al-Nakib et al. (2015) [31] who all confirmed that functional and morphologic correlation exists between loss of occlusion and articular eminence of temporomandibular joint and rate of deformation (flattening of the articular eminence) is significantly higher in completely edentulous patients than in patients with a maintained occlusion.

Sex

Koidis P.T. (1993)[32]; Zabarovic D. et al. (2000)[33]; Jasinevicius, T. R. et al. (2006)[34]; Pontual Anjos ML Dos et al. (2012)[23]; Dilhan Elguy et al. (2014) [18] confirmed sexual dimorphism in mean values of eminence inclination with age and loss of dentition. As mean values of eminence inclination and height of males were higher than those of females as

there were high prevalence of degenerative bone alteration in TMJs of the latter.

However, the results of the present study showed that the values were insignificant between both sexes for all groups on both sides and by both methods. Thus it can be concluded that sex of the patient played no role in flattening of posterior slope of articular eminence either with age or complete loss of dentition. Similar association was indicated by Luder H.U. (2002) [35] and Honda K et al. (2005) [17] who showed insignificant correlation between TMJ degeneration and sex.

Difference between left and right side of the temporomandibular joint

Zabarovic D. et al (2000) [33] concluded that right joint are steeper, The asymmetry between the left and right joint is almost a rule, and the difference reaches up to 30°. With the loss of teeth, the articular eminence inclination between the left and right joint shows more symmetry and less differences.

In the present study left and right side showed no significant difference in eminence inclination, both sides had same amount of flattening of posterior slope of articular eminence with age or complete loss of dentition. Results were thus in accordance to the study by Lamia H. Al-Nakib et al. (2015) [31] who found no statistically significant differences in eminence inclination between right and left side.

Effect of early Prosthetic rehabilitation

Pearson correlation coefficient was obtained in the present study of method 1 and 2 for Group A (II) (0.42, 0.42); Group B(III) (0.86, 0.77); Group B(IV) (0.45, 0.53) respectively. Values of group IV were much closer to group II, also the difference in the correlation coefficients between group II and IV is significantly much lower than between group II and III. Thus it could be concluded that early prosthetic rehabilitation with dentures for completely edentulous patient has high significant effect on remodeling of articular eminence as it slows down the progression of flattening of articular eminence with complete loss of dentition.

Also Post Hoc (Turkey HSD) test between Group B(IV) and Group B(III) showed positive (4±0.46, 2.56±0.49) mean difference values for both methods respectively. Thus showing that complete dentures have a favorable protective effect on temporomandibular joint structures.

Results were consisient with the findings by Heuegàrd B, Lundberg M. (1965) [36]; Hatjigiorgis G. Costas (1987) [37]; Taddei C, Frank RM, Cahen PM. (1991) [38]; Pintaudi Amorim et al. (2003) [39]; Kinga Csado, Krisztina Marton and Peter Kivovics (2012) [30] who concluded that complete dentures had a favorable protective effect on temporomandibular joint structures as group with edentulous patient who were wearing denture had similar degree of deformation of joints

as group which had dentate patients when compared to group who had edentulous patient who were not wearing denture.

Attrition

Group II did not have attrition but few who had it was confined to posterior teeth and as concluded by Whittaker, D. K., Davies, G., & Brown, M. (1985) [40] and Eversole, L. R., Pappas, J.R., Graham R. (1985)[41] ; Matsumoto M, Bolognese A. (1995)[42] attrition did not have significant effect on flattening of the posterior slope of articular eminence.

Other Factors (Stegenga et al., 1989; Arnett et al., 1996 a,b; Nitzan, 2001) [43-46] are: TMJ internal derangement, Osteoarthrosis, trauma, parafunction, unstable occlusion, dysfunction of muscle, functional overloading and increased joint friction.

Methods used for measurement

Many methods have been used in measuring the articular eminence inclination. These methods include impressions done with modeling clay, direct measurements, arthrograms, panoramic radiographs, tomographic radiographs (both corrected and uncorrected), cephalometric radiographs, scaled photographs, cephalometry using intensifying screens, protrusive condylar path, and wax. [15] Method used is a very important factor, as it influences the results. Gilboa et al. (2008)[16] concluded that the radiographic outline of the articular fossa and articular eminence provided an accurate representation of the equivalent outlines in 25 human skulls. The image of the articular eminences in a panoramic radiograph may be used to provide an indication of the degree of inclination of the articular eminence and may be of value as an aid in setting the condylar guidance in semiadjustable articulators.

The best fit line method [15] (method 1), is the factor that dictates the type of condylar path, whereas Fossa roof–eminence top method [15] (method 2) is greatly affected by the eminence height development. Thus the values obtained by both methods should be considered equally important for determining the degree of flattening of posterior slope of articular eminence. This was confirmed in the present study as a highly significant difference between the mean angle values were obtained by the two methods for left and right within each group and overall.

CONCLUSIONS:

Within the limitation of the study it could be concluded that:

1. A correlation exists between age and flattening of posterior slope of articular eminence.
2. Both age and dental status has significant effect on flattening of posterior slope of articular eminence.
3. Complete loss of dentition has significantly greater effect on flattening of posterior slope of

articular eminence as compared to age.

4. No significant difference in sex occurs in flattening of posterior slope of articular eminence either with age or complete loss of dentition.
5. No significant difference in eminence inclination between left and right side of temporomandibular joint respective to flattening of posterior slope of articular eminence could be found.
6. Early prosthetic rehabilitation with dentures for completely edentulous patient has high significant effect on remodelling of articular eminence as it slows down the progression of flattening of articular eminence with complete loss of dentition. Thus revealing that complete dentures have a favorable protective effect on temporomandibular joint structures.
7. Best-fit line method, Top-roof line method; both methods should be taken into consideration while determining the degree of flattening of posterior slope of articular eminence, as a highly significant difference between the mean angle values were obtained by the two methods for left and right within each group.

The null hypothesis tested in the study was rejected.

Thus, it could be summarized that completely edentulous patients should get rehabilitated with dentures as early as possible because complete dentures have a favorable protective effect on temporomandibular joint structures. So maintenance of the intercuspal position and the vertical dimension of occlusion is essential for harmony of temporomandibular joint. Without which an irreversible deformation might occur: the flattening of the articular eminence which might cause severe maxillofacial discomfort for the patients and further complications in the prosthetic rehabilitation.

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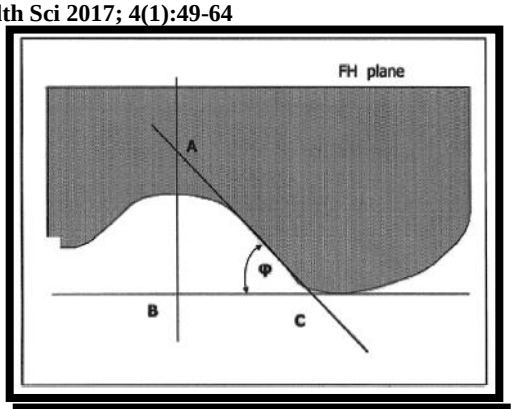
FIGURES:

Fig 1: VATECH Digital X-ray Imaging System PAX-400C

Fig 2: Patient positioned according to the median sagittal plane, according to the Frankfort horizontal plane and according to the plane of the canine with three laser beam plane pointer and four-point headrests.



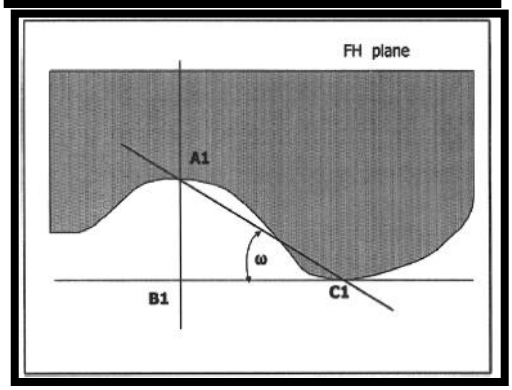


Fig 3a: Best-fit line method (Method 1)
Fig 3b: Top-roof line method (Method 2)

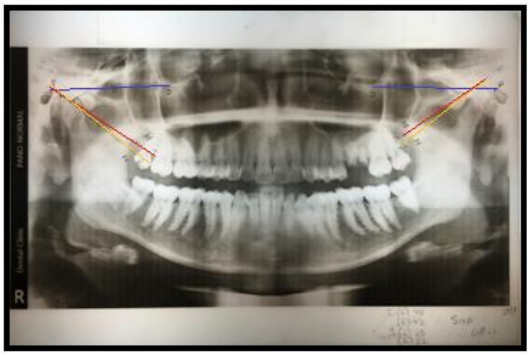


Fig 4: Radiographic analysis for 18-25 year old patients with maintained occlusion

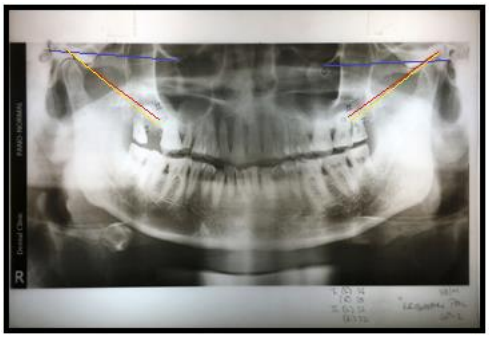


Fig 5: Radiographic analysis for patients over 50 years with maintained occlusion

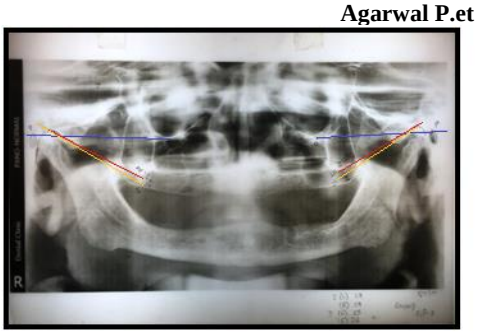


Fig 6: Radiographic analysis for patients over 50 years, edentulous for more than 1 year and not wearing dentures

Fig 7: Radiographic analysis for patients over 50 years, edentulous for more than 1 year and wearing dentures

TABLES:

T-TEST

	SEX	N	Mean(angle)	Std. Deviation	t-value	p-value
M1LEFT	Male	64	33.08	4.58	2.327	0.022
	Female	36	35.47	5.53		
M1RIGHT	Male	64	32.98	4.42	2.554	0.012
	Female	36	35.61	5.75		
M2LEFT	Male	64	29.30	4.69	2.25	0.027
	Female	36	31.58	5.20		
M2RIGHT	Male	64	29.06	4.67	2.342	0.021
	Female	36	31.53	5.68		

Table 1: Represents the T-test for comparing the deviation of mean values between Male and Female obtained by Method 1 and 2 for Left and Right side.

PEARSON CORRELATION

ANGLE/AGE		Group I	Group II	Group III	Group IV
M1LEFT	Pearson Correlation	-0.39*	-0.41*	-0.91**	-0.46*
	Sig. (2-tailed)	0.048	0.039	0	0.019
	N	25	25	25	25
M1RIGHT	Pearson Correlation	-0.40*	-0.44*	-0.82**	-0.45*
	Sig. (2-tailed)	0.042	0.027	0	0.023
	N	25	25	25	25
M2LEFT	Pearson Correlation	-0.40*	-0.43*	-0.74**	-0.59**
	Sig. (2-tailed)	0.043	0.03	0	0.001
	N	25	25	25	25
M2RIGHT	Pearson Correlation	-0.40*	-0.41*	-0.80**	-0.47*
	Sig. (2-tailed)	0.044	0.043	0	0.017
	N	25	25	25	25
** Correlation is significant at the 0.01 level (2-tailed).					
* Correlation is significant at the 0.05 level (2-tailed).					

Table 2: Depicts Pearson Correlation between age and angles obtained by Method 1 and 2 for both sides within each group.

PAIRED T-TEST

		Mean (angle)	N	Std. Deviation	Mean Difference	t-value	p-value
Pair 1	M1LEFT	33.94	100	5.047	0.010	0.091	0.928
	M1RIGHT	33.93	100	5.072			
Pair 2	M2LEFT	30.12	100	4.977	0.170	1.483	0.141
	M2RIGHT	29.95	100	5.167			
Pair 3	M1LEFT	33.94	100	5.047	3.820	29.258	<0.001
	M2LEFT	30.12	100	4.977			
Pair 4	M1RIGHT	33.93	100	5.072	3.980	28.434	<0.001
	M2RIGHT	29.95	100	5.167			

Table 3: Reveals overall deviation of mean values between left and right side for each method and between Method 1 and 2 for both sides.