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ORIGINAL ARTICLE

Comparison of the Morphology of Mandibular Condyle and Glenoid Fossa in Vertical and Sagittal Skeletal Patterns: A CBCT Study

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ABSTRACT

Background: The temporomandibular joint (TMJ) plays a critical role in maintaining a functional occlusal relationship and stable stomatognathic system. This study aimed to evaluate the differences in the morphology of the condyle, glenoid fossa, and joint space in relation to vertical and sagittal skeletal patterns in a sample of 30 orthodontic patients from the Dakshina Kannada population. **Materials & Methods:** Using cone-beam computed tomography (CBCT) for precise 3D imaging, the study assessed variations in condylar size, fossa dimensions, and joint space across Class I, II, III malocclusions and normodivergent, hypodivergent, and hyperdivergent growth patterns. **Results:** Results showed no significant difference in condylar width and length between sagittal and vertical groups. However, a significant difference in condylar height was observed between sagittal groups, with Class III patients exhibiting larger condylar height compared to Class I. No significant differences were found in the glenoid fossa dimensions or joint space measurements. These findings suggest that while condylar height varies across sagittal skeletal patterns, other TMJ dimensions remain consistent regardless of vertical and sagittal alignment. **Conclusion:** This study highlights the importance of understanding TMJ morphology for accurate diagnosis and treatment planning in orthodontics, especially regarding condylar height variations in different skeletal patterns. Further research with larger sample sizes is recommended to deepen the understanding of TMJ morphology and its impact on orthodontic outcomes.

Keywords: Condylar dimensions; TMJ morphology; skeletal patterns; CBCT; Orthodontic treatment planning.

INTRODUCTION

The mandibular condyle and the glenoid fossa at the base of the cranium form the temporomandibular joint, or TMJ. In order to maintain excellent occlusion and a stable stomatognathic system, this joint's function is essential. Since orthodontic and surgical procedures can alter the condyle-fossa relationship, knowledge of articular features may be essential for diagnosis and treatment planning.

The shape and position of the TMJ can be influenced by a number of factors, such as age, gender, the pattern of facial growth, pathological and functional changes, and alterations in dental occlusion. Given that form and function are believed to be intimately related, the temporomandibular joint's (TMJ) morphology may be associated with functional forces. One could speculate that the condyle and the fossa may differ in shape amongst individuals with varied malocclusions given that the mandible and the TMJ can be loaded differently in people with different dentofacial morphologies[1].

Clinicians can better diagnose and treat patients by evaluating the existing issues, detecting the early start of degenerative joint diseases, and understanding the optimum relationship between the condyle and the glenoid fossa. Knowing the frequent condylar variations brought on by the patients' skeletal patterns may help with temporomandibular joint diseases diagnosis and comprehension of temporomandibular disorders.

Large condyles, according to Arnett, offer stable support for occlusal alterations and are linked to several Class III malocclusions as well as some Class II. Because of a tight fit between the fossa and condyle, condyles are thought to be more resistant to displacement. Inversely small condyles usually associated with Class II malocclusion, offer unstable support for occlusal alterations, and are easily displaced because condyle, fossa, and capsule fit are loose.

However, the superimposition of nearby structures reduces the diagnostic utility of these 2D approaches, making them occasionally insufficient. As a result, both the condylar and temporal components have poor sensitivity to bone alterations. Cone-beam computed tomography (CBCT) provides various advantages over conventional computed tomographic methods, and a high level of accuracy can be reached when analysing the TMJ region. Advances in 3-dimensional (3D) imaging have made it possible to analyse the TMJ more thoroughly than ever before. When comparing various imaging methods, CBCT provides a few benefits above conventional two-dimensional radiography. It has been demonstrated that CBCT creates high-resolution, unexpanded, three-dimensional pictures that can be used to determine the number and quality of bones. Other benefits of CBCT include cost savings over CT imaging and faster scan times with lower patient absorbed doses.

The research question formulated for this study is, is there a difference in morphology of the condyle, glenoid fossa and joint space in relation to vertical and sagittal skeletal patterns? The corresponding null hypothesis is there is no difference in morphology of the condyle, glenoid fossa and joint space in relation to vertical and sagittal skeletal patterns. And the alternate hypothesis is there is difference in morphology of the condyle, glenoid fossa and joint space in relation to vertical and sagittal skeletal patterns.

This study aims to evaluate the differences in the morphology of the condyle, glenoid fossa and joint space in relation to vertical and sagittal skeletal patterns in Dakshina Kannada population. And the objectives of the study are to determine condylar size, glenoid fossa size and condyle to fossa joint space in Class I, II, III and Normodivergent, Hypodivergent, Hyperdivergent patients and comparison of measurements among these three sagittal and vertical groups.

MATERIALS AND METHODS

This retrospective study was conducted on pretreatment CBCT records of 30 orthodontic patients. It was collected from the Department of Orthodontics and Dentofacial Orthopedics, A.J.Institute of Dental Sciences, Mangaluru. At a confidence level of 95% and power of 80%, the sample size was estimated at 30 patients for detection of a standardized effect size of 0.96 using G*Power software.

The inclusion criteria were absence of any temporomandibular joint disorders and age of the patients between 18 to 40 years. The exclusion criteria were history of orthodontic or orthognathic treatment, any craniofacial skeletal deformity, cleft lip and palate, TMJ surgery, facial asymmetry with more than 4mm of menton deviation.

All CBCT scans were obtained from the NewTom cone beam imaging machine in AJIDS. The exposure parameter was a tube voltage of 110 kVp, tube current of 5 mA. The data was obtained as DICOM files.

The DICOM files were analyzed using the NemoStudio 3D software. The lateral cephalogram was obtained from the DICOM file using the Build X ray feature of the NemoStudio 3D software which eliminates the need for the availability of the lateral cephalogram for the patients. The cephalometric tracings were then done on this lateral cephalogram. The values of ANB angle and MP-SN angle were obtained from the Steiners analysis in the software.

The samples were divided into class I,II and III groups based on the ANB angle. ANB angle between 1° to 4° was classified as class I, ANB angle more than 4° was classified as class II and ANB angle of less than 1° was classified as class III. The sella-nasion to mandibular plane (SN-MP) angle was used to divide the participants into normodivergent, hypodivergent and hyperdivergent. If the SN-MP was between 30° to 38° it was classified as normodivergent, SN-MP less than 30° was classified as hypodivergent and SN-MP more than 38° was classified as hyperdivergent. Figures 1 and 2

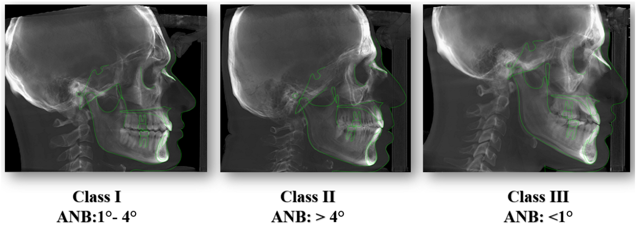

Fig. 1: Shows the classification according to sagittal skeletal pattern

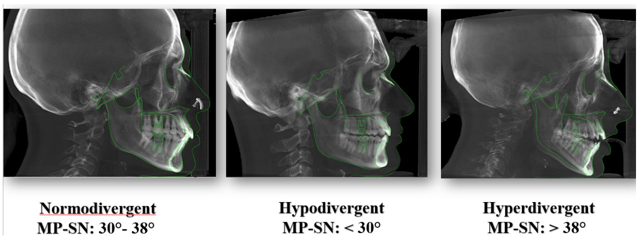

Fig. 2: Shows the classification according to vertical skeletal pattern

In the NemoStudio 3D software, the TMJ was analyzed. First the poles of both the right and left condyles were placed corresponding to the widest mesiodistal dimension of the condyle on the axial section. Following which the software automatically gives the corresponding coronal and sagittal sections of the TMJ. For the measurements 10 anatomical landmarks were identified : Cd-med, Cd-sup, Cd-lat, Cd-ant, Cd-post, Sig-inf, Sig-post, Fs-sup, At-inf and Am-inf. Table 1 Condylar width was measured in coronal sections while the rest of the measurements were measured in sagittal sections. The measurements were performed on both the left and right sides, and the mean values were used. Table 2 & Figures 3, 4, 5 and 6

Table 1: Landmarks taken on the software

Landmarks		Definition
Condyle	Medial (Cd-Med)	The most medial point of the condylar head on the coronal section
	Lateral (Cd-Lat)	The most lateral point of the condylar head on the coronal section
	Superior(Cd-sup)	The most superior point of the condylar head identified on the axial and sagittal sections
	Anterior (Cd-ant)	The most anterior point of the condylar head within a 5 mm-radius from Cd-sup on the sagittal section
	Posterior(Cd-post)	The most posterior point of the condylar head within a 5 mm-radius from Cd-sup on the sagittal section
Sigmoid	Inferior (Sig-inf)	The most inferior point of the sigmoid notch
	Posterior (Sig-post)	Perpendicular point from Sig-inf to the tangent line of the ramal posterior surface on the sagittal section
Fossa superior (Fs-sup)		The point showing the shortest distance from Cd-sup to the superior wall of the glenoid fossa
Articular tubercle (At-inf)		The most inferior point of the articular tubercle
Auditory meatus (Am-inf)		The most inferior point of the auditory meatus

This study was approved by the Institutional Ethical Committee of A.J. Institute of Dental Sciences, Mangaluru, ensuring adherence to ethical guidelines and standards in the research process.

Table 2: Measurements done on the software

Measurement		Definition
Condyle	Width	Distance between Cd-med and Cd-lat
	Length	Distance between Cd-ant and Cd-post
	Height	Perpendicular distance from Cd-sup to the line between Sig-inf and Sig-post
Fossa	Length	Distance from At-inf to a point where the line connecting At-inf and Am-inf meets the posterior wall of the glenoid fossa in the selected sagittal section
	Height	Perpendicular distance from Fs-sup to the line connecting At-inf and Am-inf in the selected sagittal section
Joint Space	Superior	Distance from Cd-sup to Fs-sup
	Anterior	The shortest distance from Cd-ant to the corresponding glenoid fossa
	Posterior	The shortest distance from Cd-post to the corresponding glenoid fossa

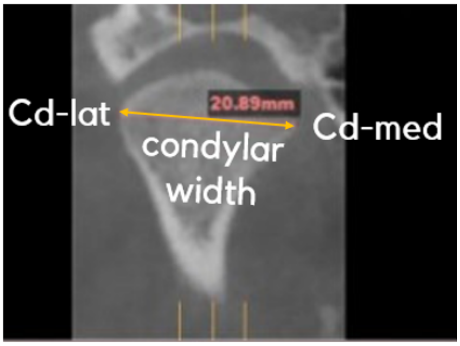

Fig. 3: Condylar Width

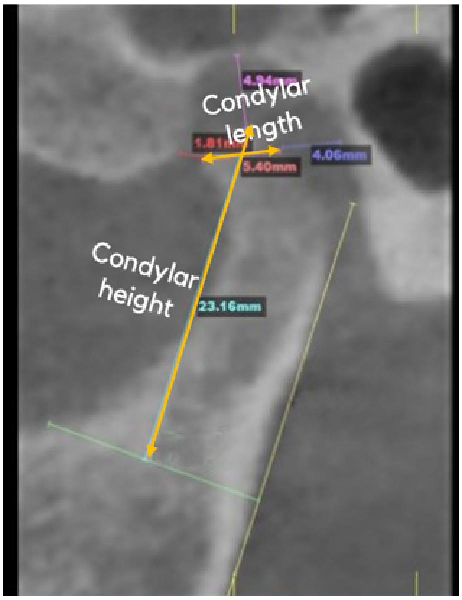

Fig. 4: Condylar Length & Height

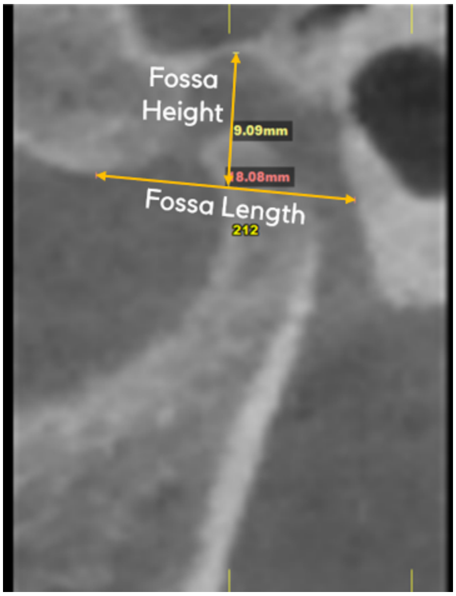

Fig. 5: Glenoid fossa Height & Length

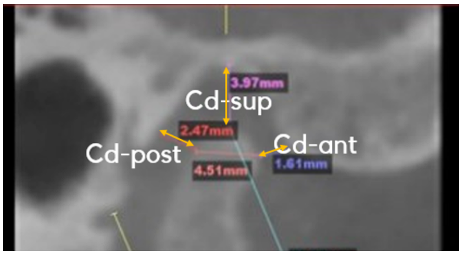

Fig. 6: Anterior, Superior & Posterior Joint Space

Statistical Analysis

One-way analysis of variance (ANOVA) was done to compare Class I, Class II and Class III groups according to sagittal skeletal patterns and also to compare hypodivergent, normodivergent and hyperdivergent groups according to the vertical skeletal patterns. The nine subgroups were compared by two way ANOVA and Bonferroni post-hoc test to evaluate the interactions between the sagittal and vertical cephalometric patterns. The data was analyzed using Statistical Package for Social Sciences (SPSS) – version 22.

RESULTS

Referring to Tables 3 and 4, with regard to the condylar morphology no significant difference was found between vertical and sagittal groups for condylar width and length. Whereas there was a significant difference seen in relation to condylar height in the sagittal group where it showed that the class III group had a larger value for condylar height than class I. There was no significant difference seen in relation to condylar height in the vertical group.

There was no statistically significant difference found in the glenoid fossa height and length and the anterior, superior, and posterior joint spaces

Table 3: Table showing the relationship between different condylar dimensions and sagittal skeletal pattern

		Mean	Std. Deviation	Sig
Condyle width	Class 1	19.7135	2.33516	0.97
	Class 2	19.512	1.89437	
	Class 3	19.7545	2.73745	
Condyle length	Class 1	7.4005	1.79751	0.713
	Class 2	7.369	1.81111	
	Class 3	6.849	1.37381	
Condyle height	Class 1	23.271	2.06019	**0.027**
	Class 2	24.1645	2.41159	
	Class 3	26.613	3.40359	
Fossa length	Class 1	18.086	1.62012	0.361
	Class 2	18.316	1.33692	
	Class 3	19.416	3.1511	
Fossa height	Class 1	9.279	0.97838	0.581
	Class 2	8.8835	1.14105	
	Class 3	9.4095	1.34346	
Superior joint space	Class 1	3.422	0.70908	0.675
	Class 2	3.193	0.94692	
	Class 3	3.029	1.2381	
Anterior joint space	Class 1	2.0915	0.25966	0.792
	Class 2	2.0875	0.37871	
	Class 3	2.3005	0.67295	
Posterior joint space	Class 1	2.3345	0.78431	0.956
	Class 2	2.795	1.25074	
	Class 3	2.591	0.92174	

DISCUSSION

The Temporomandibular joint plays a very important role in orthodontic treatment. Because orthodontic and surgical procedures can alter the condyle-fossa relationship, knowledge of articular features may be crucial for diagnosis and treatment planning. When used correctly, CBCT imaging can, in comparison to traditional radiography methods, offer precise and significant diagnostic information.

This present study aimed to evaluate the differences in the morphology of the condyle, glenoid fossa and joint space in relation to vertical and sagittal skeletal patterns in Dakshina Kannada population.

With regard to the condylar morphology no significant difference was found between vertical and sagittal groups for condylar width and length. Whereas there was a significant difference seen in relation to condylar height in the sagittal group where it showed that the class III group had a larger value for condylar height than class I. There was no

Table 4: Table showing the relationship between different condylar dimensions and vertical skeletal pattern

		Mean	Std. Deviation	Sig
Condyle width	Normodivergent	20.337	1.49896	0.382
	Hypodivergent	19.738	3.17924	
	Hyperdivergent	18.91	1.75761	
Condyle length	Normodivergent	7.886	1.62998	0.193
	Hypodivergent	7.189	1.43503	
	Hyperdivergent	6.553	1.70647	
Condyle height	Normodivergent	25.498	3.35165	0.583
	Hypodivergent	24.324	2.60798	
	Hyperdivergent	24.232	3.02468	
Fossa length	Normodivergent	19.276	2.8639	0.51
	Hypodivergent	18.215	1.84454	
	Hyperdivergent	18.331	1.76169	
Fossa height	Normodivergent	9.771	0.95068	0.12
	Hypodivergent	9.068	0.87572	
	Hyperdivergent	8.741	1.39425	
Superior joint space	Normodivergent	3.208	0.7375	0.833
	Hypodivergent	3.357	1.02271	
	Hyperdivergent	3.087	1.17835	
Anterior joint space	Normodivergent	2.341	0.64666	0.189
	Hypodivergent	2.005	0.21036	
	Hyperdivergent	2.14	0.41679	
Posterior joint space	Normodivergent	2.245	0.85907	0.432
	Hypodivergent	2.53	0.60902	
	Hyperdivergent	2.951	1.32496	

significant difference seen in relation to condylar height in the vertical group.

There was no statistically significant difference found in the glenoid fossa height and length and the anterior, superior and posterior joint spaces

One of the limitation of the study was the small sample size. It can be overcome by a well organized prospective study with a larger sample size

CONCLUSION

The present study showed that the TMJ morphology varied in relation to condylar height between the Class I and Class III sagittal groups where the Class III showed higher values for condylar height than Class I.

The awareness of regular condylar variations brought on by the patient's skeletal patterns may aid in the identification of temporomandibular joint pathologies and temporomandibular disorders and also help in orthodontic treatment planning.

it is advisable for practitioners to pay attention to the condylar condition before initiating treatment

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