International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Comparative Analysis of Condylar Guidance and Curve of Spee in Dentate Individuals with and Without Temporom and ibular Joint Disorders: An in Vivo Study

Dr. Saloni Goel[1], Dr. Vishwa Deepak Singh[2], Dr. Shalabh Kumar[3], Dr. Akash Gopi[4]

ABSTRACT

Statement of problem. Even though occlusal morphology and temporomandibular joint dynamics are known to be related, little is known about how condylar guidance affects the Curve of Spee, especially in those who have temporomandibular joint diseases.

Purpose. This in vivo study aimed to assess and compare the curve of spee and condylar guidance in dentate persons with and without temporomandibular joint diseases, as well as to ascertain the relationship between these parameters.

Material and methods. Twenty dentate people between the ages of 20 and 30 were chosen based on predetermined inclusion and exclusion criteria. Two groups of 10 participants each were formed: Subjects without TMJ condition made up Group I, whereas those with a diagnosis made up Group II. Casts were created in dental stone after alginate was used to provide diagnostic impressions of the maxillary and mandibular arches. A digital vernier caliper was used to measure the depth of the spee curve on the mandibular castings. Cone-beam computed tomography (CBCT) scans were used to calculate condylar guidance in relation to the Frankfort horizontal plane. The normal distribution of data was confirmed by statistical analysis using the Kolmogorov-Smirnov test.

A significance threshold of α=.05 was used to investigate correlations between the curve of spee and condylar guidance, as well as intergroup comparisons.

Results. Group I mean right condylar angulation was 45.08° ± 8.58, whereas Group II was 41.79° ± 7.93 (P=.05). The groups' left condylar angulation did not differ statistically significantly (P=.42). Group I had a considerably higher mean right curve of spee depth (2.52 ± 0.79 mm) than Group II (1.09 ± 0.73 mm) (P=.00). Additionally, Group I left spee curve had a higher mean value (2.02 ± 0.91 mm) than Group II's (1.01 ± 0.73 mm) (P=.06). Condylar angulation and the curve of spee depth were shown to be positively correlated.

Conclusions. People with temporomandibular joint abnormalities showed lower condylar guidance values and a relatively flatter Spee curve than people without temporomandibular joint disorders, within the constraints of this study. The curve of Spee and condylar guidance showed a positive association, indicating a functional connection between temporomandibular joint movements and occlusal morphology.

CLINICAL IMPLICATIONS
Within the limitations of this study, condylar guidance and curve of spee should be considered during prosthodontics rehabilitations. Changes in these parameters may be associated with temporomandibular disorders and may influence occlusal treatment planning and long term prosthetic outcomes.

Keywords: CBCT; Condylar guidance; Curve of Spee; Occlusion; Temporomandibular joint disorder

INTRODUCTION
Occlusion, the temporomandibular joint (TMJ), and neuromuscular components must work in unison to maintain the stomatognathic system's functional harmony.[1-3] Two important factors affecting mandibular dynamics and occlusal stability are the curve of Spee (COS) and condylar guidance (CG).[4] Although the precise association between these factors and temporomandibular joint disorders (TMD) is yet unknown, changes in these parameters have been linked to TMD.[5,6]
Whether occlusal alterations, such as differences in COS, are adaptive reactions to changed TMJ function or contribute to TMD is a continuing clinical conundrum. Prior research has assessed COS and CG separately, with varied and even contradicting results.[7] Methodological differences, diverse study populations, and the infrequent application of integrated in vivo evaluation methodologies all contribute to this lack of agreement.[8]
The simultaneous assessment of COS and CG in dentate people without confounding variables like previous orthodontic or prosthodontic therapy is a significant research gap.[9] There is little proof that these characteristics can be correlated utilizing standardized techniques that include radiographic and clinical analysis.[10]
Therefore, this study aims to evaluate and compare COS and CG in individuals with and without TMD using CBCT and diagnostic cast analysis to better understand their functional relationship.
Hypothesis. There is no significant difference in COS and CG between individuals with and without TMD, and no correlation exists between these parameters.

MATERIALS AND METHODS
This comparative study was conducted in the Department of Prosthodontics and Crown and Bridge, Teerthanker Mahaveer Dental College and Research Centre(Mbd) India, after obtaining ethical approval from the institutional review board (Ref No: TMDCRC/IEC/TH/23-24/PRO 05). Every participant provided written informed consent.
A total of 20 dentate individuals aged between 20 and 30 years were selected and divided into 2 groups (n=10 each): Group I included individuals without temporomandibular disorder (TMD), and Group II included individuals diagnosed with TMD based on clinical findings such as reduced mouth opening (<30 mm), joint sounds, tenderness on palpation, or signs of joint pathology.
Inclusion criteria were individuals with fully erupted permanent dentition, no history of occlusal adjustment, and age between 20 and 30 years. Participants in Group II additionally presented with clinical signs & symptoms of TMD.
Exclusion criteria included individuals with mixed or primary dentition, history of orthodontic treatment, presence of prosthesis, missing teeth, faulty restorations, periodontal disease, or systemic conditions affecting joint health.

Casts were promptly poured in Type III dental stone after irreversible hydrocolloid imprint material was used to create maxillary and mandibular diagnostic impressions. The casts were evaluated for accurate reproduction of occlusal anatomy before measurements.

The depth of the curve of Spee (COS) was measured on mandibular casts using a standardized method. An occlusal plane was established by placing a flat occlusal plate contacting the mandibular canine cusp tip anteriorly and distobuccal cusp tip of the 2^{nd} molar posteriorly (figure 1). A digital vernier caliper with an accuracy of 0.01 mm was used to measure the perpendicular distance between this plane and the mesiobuccal cusp point of the mandibular 1^{st} molar (figure 2). Every measurement was taken three times, and analysis was done using the mean value.

Condylar guidance (CG) was determined using CBCT imaging. Images were analyzed in the sagittal plane using the Frankfort horizontal plane as the reference (figure 3). The condylar guiding angle was measured as the angle created between the articular eminence's slope and the reference plane.

Measurements were made bilaterally using digital imaging software. All measurements were carried out under standardized conditions by calibrated examiners for both subjects without temporomandibular joint disorder (Fig. 4) and those with temporomandibular joint disorder (Fig. 5).

Statistical software was used to conduct the statistical analysis Kolmogorov-Smirnov test was used to determine the normality of the data. Intergroup comparisons were made using the independent Student t test, and correlation between CG and COS was evaluated. The significance threshold was established at α=.05.

RESULTS

Mean condylar angulation and curve of spee measurements were compared between the two groups. Statistical analysis was performed using parametric tests. Student's t-test and analysis of variance (ANOVA) were used for intergroup comparisons.

The relationship between condylar guidance and the curve of spee was assessed using Pearson's correlation coefficient. A p-value of less than 0.05 was deemed statistically significant and descriptive statistics such as mean and standard deviation were computed.

Mean right condylar angulation in Group I was **45.08 ± 8.57°**, whereas in Group II it was **41.79 ± 7.93°**. The groups' differences were statistically significant. The mean left condylar angulation in Group I was **43.20 ± 9.49°**, while in Group II it was **40.60 ± 9.01°**, which was not statistically significant. The mean curve of Spee on the right side was **2.52 ± 0.78 mm** in Group I & **1.09 ± 0.73 mm** in Group II, showing a highly significant difference. Mean curve of Spee on the left side was **2.02 ± 0.91 mm** in Group I & **1.01 ± 0.72 mm** in Group II.

Overall, individuals without temporomandibular disorders demonstrated greater condylar angulation and a deeper curve of Spee compared with individuals with temporomandibular disorders.

DISCUSSION

The current study assessed the correlation between the curve of Spee (COS) and condylar guidance (CG) in people with and without temporomandibular disorders (TMD). The results showed that those with TMD had lower condylar guidance values and a flatter Curve of Spee, with a positive association between the two parameters, which is in line with findings from earlier research.[11-14] The observed decrease in CG among TMD subjects is in line with findings from earlier researchers who hypothesized that changes in condylar inclination could be caused by pathological or adaptive changes in the temporomandibular joint, such as disc displacement and articular eminence remodeling. Similar findings have been shown in CBCT-based research, where altered condylar movement patterns were linked to worse joint function.[15,16]

Additionally, the current study showed that those with TMD had a flatter COS. This result is consistent with research showing changes in occlusal curvature as an adaptive reaction to variations in occlusal stress and joint function.[17,18] A flatter COS may minimize joint stress by reducing posterior interferences during mandibular excursions.[19] Occlusal variables alone may not be the key etiologic contributors to TMD, since other writers have shown no statistically significant correlation between COS depth and TMD symptoms.[20,21] This disparity might be explained by variations in measuring methods, demographic characteristics, and research design.

The idea that occlusal morphology and TMJ dynamics are functionally interdependent is supported by the study's finding of a positive association between CG and COS.[22] Studies assessing sagittal condylar guidance and occlusal curvature have shown similar correlations, indicating that deeper occlusal curvatures are linked to steeper condylar routes in order to promote posterior disclusion during mandibular motions.[23] However, because to the lack of functional neuromuscular adaptation under experimental settings, several in vitro investigations have not been able to show a meaningful association.[24,25]

Occlusal morphology may be more susceptible to alterations in joint function under pathological settings, according to the greater relationship found in the TMD group in this study.[26] This result is consistent with other research suggesting that occlusal alterations might be secondary adaptations rather than the main cause of TMD.[27]

These results highlight the significance of assessing both CG and COS during occlusal repair and prosthodontic rehabilitation from a clinical standpoint. Long-term treatment results and occlusal harmony may be jeopardized if their interaction is ignored.

Due to the cross-sectional design and small sample size of this study, it is not feasible to establish a causal relationship. To further understand the dynamic link between TMJ function and occlusal morphology, future research with larger sample numbers and longitudinal designs are advised.

CONCLUSION

Within the limitations of this study, the following conclusions were drawn:

1. Individuals with temporomandibular disorders demonstrated reduced condylar guidance values.
2. The curve of Spee was flatter in individuals with temporomandibular disorders.
3. A positive relationship exists between condylar guidance and occlusal curvature.

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TABLES

Table 1. Comparison between group 1 & group 2

Group Statistics					
	Groups	N	Mean	Std. Deviation	p Value
Condylar angulation (Right) (in degree)	Group 1	10	45.0800	8.57794	.05 **
	Group 2	10	41.7900	7.93064	
Condylar angulation (Left) (in degree)	Group 1	10	43.2000	9.49889	.42
	Group 2	10	40.6000	9.01271	
COS (Right) (in mm)	Group 1	10	2.5200	.78994	
	Group 2	10	1.0900	.73250	.00 **
COS (Left) (in mm)	Group 1	10	2.0200	.91019	.06
	Group 2	10	1.0100	.72793	

FIGURE LEGENDS

Figure 1: Measurement of curve of spee on mandibular diagnostic cast using Occlusal plate as reference.

Figure 2: Measurement of curve of spee depth on mandibular diagnostic cast.

Figure 3: Sagittal cbct image illustrating frankfort horizontal (FH) plane (blue line) used as the reference plane.

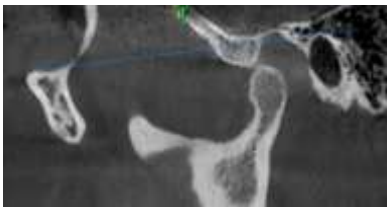

Figure 4: CBCT-based measurement of condylar guidance angle in subjects without temporomandibular disorder.

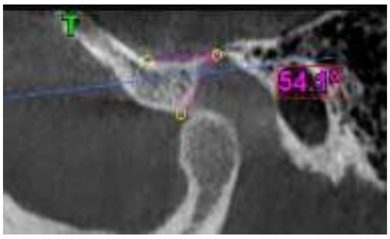

Figure 5: CBCT-based measurement of condylar guidance angle in subjects with temporomandibular disorder.