Assessment of Reliability of Cone-beam Computed Tomography in Skeletal and Dental Discrepancy

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ABSTRACT

Aim: The present study was conducted to evaluate the reliability of cone-beam computed tomography (CBCT) in dental asymmetry with skeletal midline deviation.

Materials and methods: This study was conducted on 124 patients (males 52, females 72) who underwent orthodontic treatment. The CBCT scan was obtained with the Planmeca machine. Three maxillofacial radiologists evaluated 10 landmarks and 12 distances on maxillary and mandibular arches on CBCT images in all patients.

Results: Interobserver mean difference at point 1 was 0.33; point 2, 0.34; point 3, 0.32; point 4, 0.58; point 5, 0.56; point 6, 0.44; point 7, 0.28; point 8, 0.22; point 9, 0.54; point 10, 0.21; point 11, 0.34; and point 12, 0.36. The discrepancy between intra- and interobserver was not considerable ($p > 0.05$).

Conclusion: Cone-beam computed tomography is useful for diagnosis of skeletal asymmetry.

Clinical significance: Cone-beam computed tomography is a reliable and reproducible tool for diagnosis of skeletal asymmetry for successful orthodontic treatment.

Keywords: Asymmetry, Cone-beam computed tomography, Malocclusion.

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INTRODUCTION

Malocclusion is the leading cause of unaesthetic appearance for which the patient visit the dentist to seek advice. Malocclusion among population is matter of concern as teeth are the first that are exposed when we speak. Facial asymmetry and dental midlines are variable features that are not coinciding with each other. Angle has classified malocclusion into class I, class II, and class III malocclusion.¹ There are further modifications in Angle's classification. Class II div I is considered when the distobuccal cusp of the maxillary first molar coincides with the mesiobuccal groove of the mandibular first molar. There is increased overjet in class II division I malocclusion. In class II div II malocclusion, there is retroclined maxillary central incisors leading to decreased overjet. Dewey's classification of malocclusion also provides useful information. To correct dental arch rotation, extractions is required to correct a dental midline shift.² Thus, skeletal and dental discrepancy has to be corrected for the management of malocclusion. To diagnose patient's dental asymmetry in association with skeletal midline deviation in the midsagittal plane, various methods have been employed.³

Bolt suggested that symmetric grid or bow divider with ruler can be used in identifying asymmetry.⁴ Several authors have experimented scan images of plaster models with the help of computers. Posteroanterior (PA) radiography skull and mandible, as recommended by Burstone, is one of the methods to calculate divergence in the maxilla and mandible along with the midline of the upper and lower dental aspect to skeletal one.⁵ But this technique has its limitations. Considering, median raphe as the patient's skeletal midline, the dental midline can be evaluated. Studies suggested the role of dental casts in establishing the relationship between teeth and bone.⁶ Cone-beam computed tomography (CBCT) is one of the recent diagnostic aids in assessing skeletal and dental discrepancy. The present study was conducted

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to evaluate the reliability of CBCT in dental asymmetry with skeletal midline deviation.

MATERIALS AND METHODS

This study was conducted in the Department of Orthodontics and Dentofacial Orthopedics, College of Dental Science and Hospital, Rau, Indore on 124 patients (males 52, females 72) who underwent orthodontic treatment. An ethical approval about the study was obtained from the institutional ethics committee prior to the study. All participants' informed approval was attained prior to the study.

The inclusion criteria were patient's age ranged 14–25 years and those who willingly participated in the study. The exclusion criteria were patients with missing anterior and molars and patients with cleft and palate.

All participants underwent CBCT scan taken with the Planmeca machine operating at 140 kVp and 10 mA. The 1 mm slices were used in the study. The Frankfort horizontal plane was oriented horizontally and the skeletal midline was compared with the sagittal

Fig. 1: Maxillary landmarks and distances

Fig. 2: Mandibular landmarks and distances

Fig. 3: Landmarks in midline

plane. Three maxillofacial radiologists evaluated 10 landmarks (5 maxillary and 5 mandibular) and 12 distances (6 maxillary, 4 mandibular, and 2 midline) on maxillary and mandibular arches on CBCT images in all patients (Figs 1 to 3). Landmarks were plotted on the axial view of multiplanar reconstruction (MPR). All the investigation was done by three trained investigators. To overcome intraobserver observations, each observer recorded three values for each landmark at different time and their mean was taken as the final value.

Results were tabulated and statistically evaluated by SPSS IBM version 21 using intraclass correlation coefficients (ICCs) and compared using Chi-square and *t* tests. The *p* value was believed considerable at lower than 0.05.

RESULTS

Table 1 shows five maxillary and five mandibular landmarks used for the study. Table 2 shows six maxillary, four mandibular, and two midline distances measured in the study (Figs 1 to 3). Table 3 shows intraobserver and interobserver reliability measured by ICC for the distances measured. The discrepancy between intra- and interobserver was not considerable ($p > 0.05$).

Figure 4 shows intraobserver mean difference of distance measured between the landmarks as 12 points. At point 1 was 0.33; point 2, 0.34; point 3, 0.32; point 4, 0.58; point 5, 0.56; point 6, 0.44; point 7, 0.28; point 8, 0.22; point 9, 0.54; point 10, 0.21; point

Table 1: Landmarks used in the study

Symbols	Description
Maxillary landmark	
UR6	Right molar mesiobuccal cusp tip
UR3	Right canine cusp tip
UML	Skeletal midline at upper incisors incisor edge
UL6	Left molar mesiobuccal cusp tip
UL3	Left canine cusp tip
Mandibular landmark	
LR6	Right molar mesiobuccal cusp tip
LR3	Right canine cusp tip
LML	Skeletal midline at lower incisors incisor edge
LL6	Left molar mesiobuccal cusp tip
LL3	Left canine cusp tip

Table 2: Measurements used in the study

Distance	Description
Maxillary measurements	
1	Distance between UR3 and UML
2	Distance between UL3 and UML
3	Distance between UR6 and UML
4	Distance between UL6 and UML
5	Distance between UR6 90° and the skeletal midline
6	Distance between UL6 90° and the skeletal midline
Mandibular measurements	
7	Distance between LR3 and LML
8	Distance between LL3 and LML
9	Distance between LR6 and LML
10	Distance between LL6 and LML
Midline	
11	Distance between skeletal midline and midline of upper teeth
12	Distance between skeletal midline and midline of lower teeth

11, 0.34; and point 12, 0.36. Figure 5 shows interobserver difference at 12 points, which was nonsignificant. The discrepancy between intra- and interobserver was not considerable ($p > 0.05$).

DISCUSSION

Malocclusion is the leading dental complaint for which patients visit a dentist. It is quite common among youngsters. Dental asymmetry is the biggest problem most of the people have encountered. Careful evaluation of anatomical landmarks and points may be useful in assessment of malocclusion in patients. There have been numerous methods proposed in the past.^{7,8} This study was conducted to assess the asymmetry in relation to canine, molars, and dental midline in concern to the skeletal midline using CBCT. We included 124 patients with malocclusion. In all patients, the CBCT scan was obtained with the Planmeca machine. The exposure parameters such as kVp and mA were kept constant in all patients.

We observed that five landmarks in maxilla and five in mandibles were utilized. These landmarks have been studied in

the previous studies also and are capable of providing dental and skeletal discrepancy.

It consisted of right molar mesiobuccal cusp tip (UR6), right canine cusp tip (UR3), skeletal midline at upper incisors incisor edge

Table 3: Intra- and interobserver reliability measured by ICC for the measured distances

Values	Intraobserver		Interobserver	
	Number	Percentage	Number	Percentage
>0.90	62	50	60	48.4
0.75–0.90	43	34.6	42	33.8
0.45–0.75	19	15.4	22	17.8
<0.45	0	0	0	0
Total	124	100	124	100

$p > 0.05$

Fig. 4: Reliability measured by intraclass ICC for each distance

Fig. 5: Reliability measured by interclass ICC for each distance

(UML), left molar mesiobuccal cusp tip (UL6), left canine cusp tip (UL3) and five in mandible right molar mesiobuccal cusp tip (LR6), right canine cusp tip (LR3), skeletal midline at lower incisors incisor edge (LML), left molar mesiobuccal cusp tip (LL6), and left canine cusp tip (LL3).

Sanders et al. in their study utilized Dolphin 3D in evaluation parameters in relation to dental, cranial base, maxillary, and mandibular teeth. A total of 34 anatomical landmarks were evaluated with CBCT scans. Using 3D, all reference points were digitized and assessed by means of dental and skeletal dimensions. The study revealed slightly longer length of dental arches on the left side than the right side. There was slight dental midline discrepancy.⁹

We assessed six distances in the maxilla, four in the mandible, and two in the midline. It was distance between the right canine cusp tip and the skeletal midline at the upper incisors incisor edge, distance between the left canine cusp tip and the skeletal midline at the upper incisors incisor edge, distance between the right molar mesiobuccal cusp tip and the skeletal midline at the upper incisors incisor edge, distance between the left molar mesiobuccal cusp tip and the skeletal midline at the upper incisors incisor edge, distance between the right molar mesiobuccal cusp tip 90° and the skeletal midline, distance between the left molar mesiobuccal cusp tip 90° and the skeletal midline, distance between the right canine cusp tip and the skeletal midline at the lower incisors incisor edge, distance between the left canine cusp tip and the skeletal midline at the lower incisors incisor edge, distance between the right molar mesiobuccal cusp tip and the skeletal midline at the lower incisors incisor edge, distance between the left molar mesiobuccal cusp tip and the skeletal midline at the lower incisors incisor edge, distance between the skeletal midline and the midline of upper teeth, and distance between the skeletal midline and the midline of lower teeth.

Ruellas et al. in their study assessed dental asymmetry in relation to the skeleton midline. For the study, landmarks and distances were evaluated using CBCT. Authors observed ≥ 0.9 in 90% subjects and 83% variables for intra- and interobserver, respectively. It was found that ICC for distances was ≥ 0.9 for 58 and 42%, respectively.¹⁰ In our study, intraobserver and interobserver reliability measured by ICC for the distances measured, which was nonsignificant ($p > 0.05$). Ludlow et al. in his study found intraexaminer mean differences for variable as ≤ 0.05 mm on dental casts and ≤ 0.32 mm on 3D digital study models.¹¹

We measured mean difference for distances from skeletal to dental midlines and it was found to be ≤ 0.4 mm. Good reliability between observers was observed with the molars perpendicular line to the skeletal midline. Palatal rugae, as a reference point used for conventional or 3D digital models, is consistent for growing patients. But due to different shapes and curvatures of palatal raphae, this cannot be considered as good choice for the skeletal midline.

Kapila et al. in his study measured landmarks on stack of slices instead of rendered images. In the present study, measurement was done on axial sections of MPR. Cone-beam computed tomography offers less patient radiation exposure and is relatively cheaper and accurate as compared to the CT scan. The radiation doses used in CBCT are comparable to full-mouth radiographs. It can provide multiple views of 0.1 mm thickness and has ability to show soft tissues, sinus, TMJ, etc.¹²

Almeida et al. conducted a study to assess skeletal and dental discrepancy using CBCT and found CBCT as one of useful tools in determining malocclusion. He further stated that 3D images are

better indicative of malocclusion when it is compared with skeletal malocclusion.¹³ Abdelkarim et al. from his review stated that CBCT can be used as a diagnostic tool for various orthodontic treatments need.¹⁴ Ruellas et al. concluded from his study that CBCT is a valid method to assess skeletal asymmetry.³

Evaluation of orthodontic patients with CBCT images helps to rule out skeletal discrepancy for successful treatment outcome in practice of the primary care procedure. The limitation of the present study is the undersized sample range. Further studies are required to evaluate the validity of CBCT on a larger sample size.

CONCLUSION

Dental asymmetry can be assessed with CBCT images. Dental asymmetry can be effectively evaluated and asymmetry of incisors, molars, and canines in relation to skeletal midline may be efficiently determined with CBCT. This study helps to utilize CBCT in evaluation of dental and skeletal discrepancy for effective management of malocclusion cases.

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