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Correlation of Cephalometric Measurements of TMJ on CBCT and MR Images in patients with Traumatic TMJ sequelae

Ujjya Pandey,[a] BDS, Atul Sattur,[b] MDS, Marcelo Matos,[c] DDS, Krishna Burde,[d] MDS

a. PG Student, Dept Oral Medicine and Radiology, SDM College of Dental Sciences and Hospital, Sattur, Dharwad, Karnataka, India
b. Professor Dept Oral Medicine and Radiology, SDM College of Dental sciences and Hospital, Sattur, Dharwad, Karnataka, India
c. Private Clinic, Salvador, BA, Brazil
d. Professor and Head, Dept Oral Medicine and Radiology, SDM College of Dental Sciences and Hospital, Sattur, Dharwad, Karnataka, India
Corresponding author: Prof. Dr. Atul P. Sattur, atulsattur@gmail.com

Abstract

Objective: To identify and measure spatial relationship of condyle using cephalometric method on Cone Beam Computed Tomography (CBCT) in patients with Temporomandibular Joint traumatism and to correlate it with Magnetic Resonance (MR) imaging findings.

Methods: 34 patients (61 TMJs) were included with the complaint of Temporomandibular Joint Disorders (TMJDs) along with historic reference of traumatism to the part of the mandible or joint. Anteroposterior Relationship (in %) of total of 61 joints on CBCT were divided into four groups: Group I- <46%, Group II - 46-53%, Group III – 54-58%, Group IV - >59% and were corelated with MR imaging findings. Statistical tests employed were Fischer's exact test and the Chi-square test.

Results: Group II followed by group III demonstrated high frequency of deformed disc in open and closed mouth, disc displacement, marrow edema and effusion.

Conclusion: Statistical evidence does not support any correlation between the anteroposterior relationship of condyle in the fossa on CBCT and any of the MRI variables. However, the results of this investigation confirm that in patients with traumatic TMJ sequelae presented with altered spatial relationship of the condyle within the fossa and MR Imaging indications of internal derangement.

Key Words: Cone Beam Computed Tomography (CBCT), Magnetic Resonance Imaging (MRI), TMJ, joint trauma

Introduction

For many years, various etiological factors such as traumatic, bacterial, autoimmune, and occlusal causes were considered for Temporomandibular Joint Disorders (TMJDs).[1] Traumatic causes of TMJDs have been mentioned in various literature as a reference to lesions that can occur in the Temporomandibular Joint (TMJ) and includes both hard and soft tissue lesions.[1-8] These traumatic events can result from a direct injury as obvious as a blow to the jaw or indirect, such as a sudden and strong dislocation of the mandible or whiplash injury. These injuries may alter the existing balance of the temporomandibular joint (TMJ) and can cause several problems such as effusion, hemarthrosis, dislocation, internal derangement, fibrous adhesion, ankylosis, fracture and limitation or deviation of jaw opening.[9-14]

When the trauma involves articular disk, it can lead to disc displacement or perforation. Secondary displacement of the articular disk can also occur due to an injury to a ligament as a consequence of trauma. When hard tissue such as condylar head or neck are involved, it might lead to fractures, causing morphological alterations in joint structures, which in turn produces morpho-functional dysfunction[15,16] and an altered spatial relationship of the mandibular head within the mandibular fossa of the TMJ. These alterations might also lead to dislocation of articular disc between the two structures, deformation of the shape of the disc, effusion or degenerative changes. These morphological alterations and the spatial position of condyle can now be more precisely observed and studied with the help of diagnostic tools such as Cone Beam Computerized Tomography (CBCT), which is commonly chosen for evaluating bony components. The effect of trauma on the soft tissue component can be studied with the help of Magnetic Resonance Imaging (MRI), being the gold standard method for assessing disc derangements and soft tissue changes.

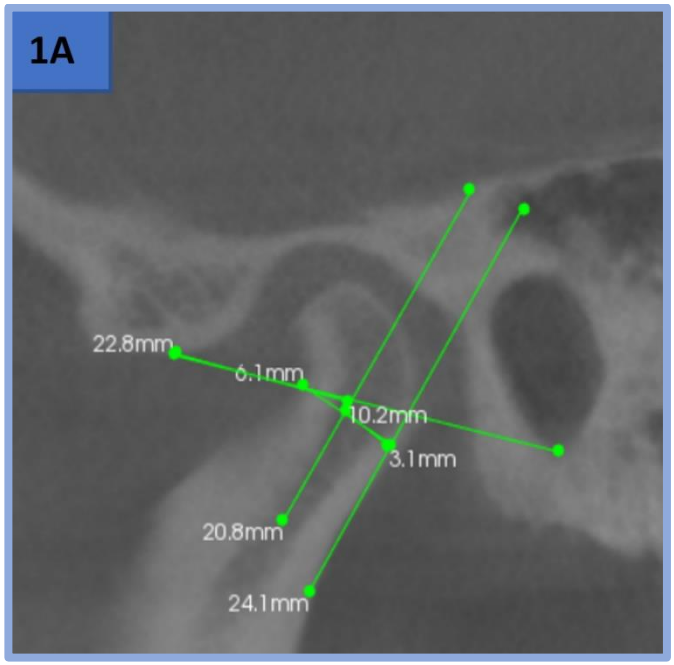
Objective

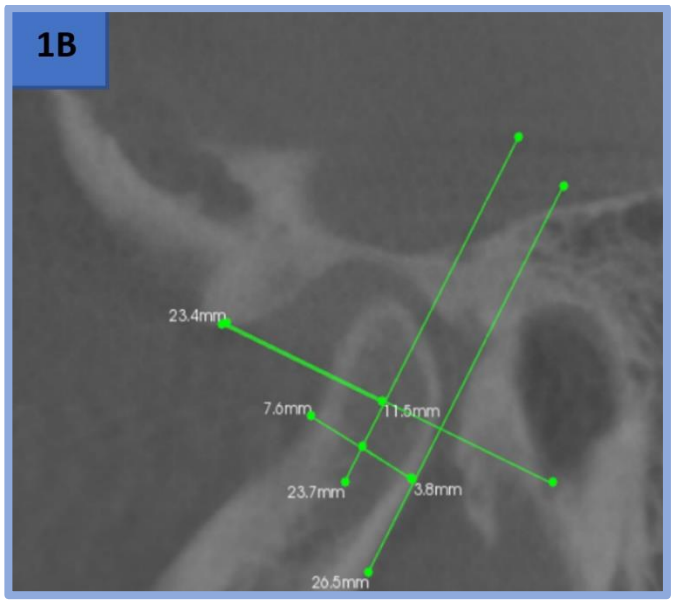
The aim of the present study was to identify and measure the spatial relationship of condyle using the cephalometric method on CBCT images in patients with temporomandibular joint traumatism and also to assess and correlate it with MR images from the same patients.

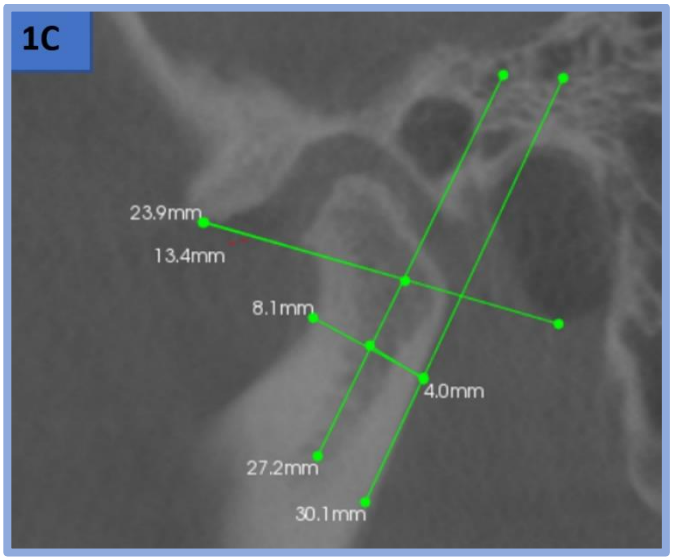
Material and methods

This study included 34 patients, who reported to the Department of Oral Medicine and Radiology, Shri Dharmasthala Manjunatheshwara College of Dental Sciences and Hospital (SDMCDS), Dharwad, Karnataka, India with the complaint of TMJDs along with a historic reference of traumatism in the mandible or TM joint. Patients who had received previous treatments or undergone surgery were excluded from the study. CBCT and MRI were obtained for both TMJs of each patient within a week of the clinical examination. CBCT scans were made with Carestream (Kodak) 9000 machine with exposure parameters of 90 Kvp, 12 mA, 10.8 seconds, with a field of view of 3 x 5 cm. Patients were positioned within the scanner standing straight and were instructed to hold still with their teeth together in maximum intercuspation. All the patients were then encouraged to undergo T-1 and T-2 MRI scans of their TMJs in the open and closed mouth positions with a General Electric (GE) MRI machine of 1.5 Tesla and using dual surface coils designed specifically for the TM Joints. A total of 61 joints were analyzed as independent units (7 joints could not be traced as areas covered during imaging were inadequate for tracing). Anteroposterior spatial relationship of condyle within the mandibular fossa of TMJ was analysed on parasagittal images according to the methodology used in "Application of a Cephalometric Method to the Temporomandibular Joint in Patients with or Without Alteration in the Orientation of the Mandibular Condyle Axis," [17] **See Figure 1**.

The Anteroposterior Relationship (in %) of total of 61 joints on CBCT were divided into four groups: Group I- <46%, Group II -46-53%, Group III –54-58%, Group IV ->59%. **See figures 1A-D**. Seven variables on MRI i.e. shape of the disc in closed/open mouth, position of posterior band, direction of displacement of disc, disc reducibility in open mouth, condylar marrow edema and effusion were analysed within each group. Two Maxillofacial Radiologists experienced with interpreting MRI and CBCT scans of the TMJ during their daily clinical practice interpreted all of the CBCT and MRI images. The CBCT interpretations were then correlated with interpretations of MRI images. **See Table 1.** All patients provided informed consent and the protocol followed with the World Medical Association's Declaration of Helsinki.







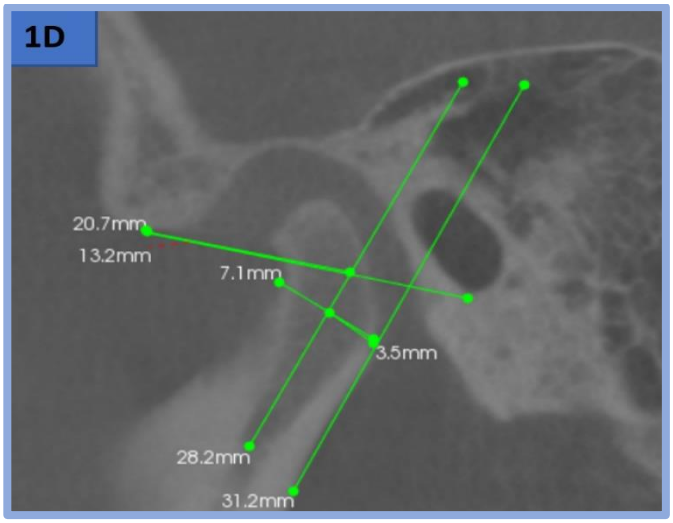


Figure 1A-1D. A Cone Bean Computed Tomogram image showing closed mandibular head sagittal view. Sequel of trauma in childhood with pathological growth axis. Image A-D depicts Group I-IV respectively formed according to cephalometric Anteroposterior Relationship. (calculated by the formula A-E/A-C X 100)

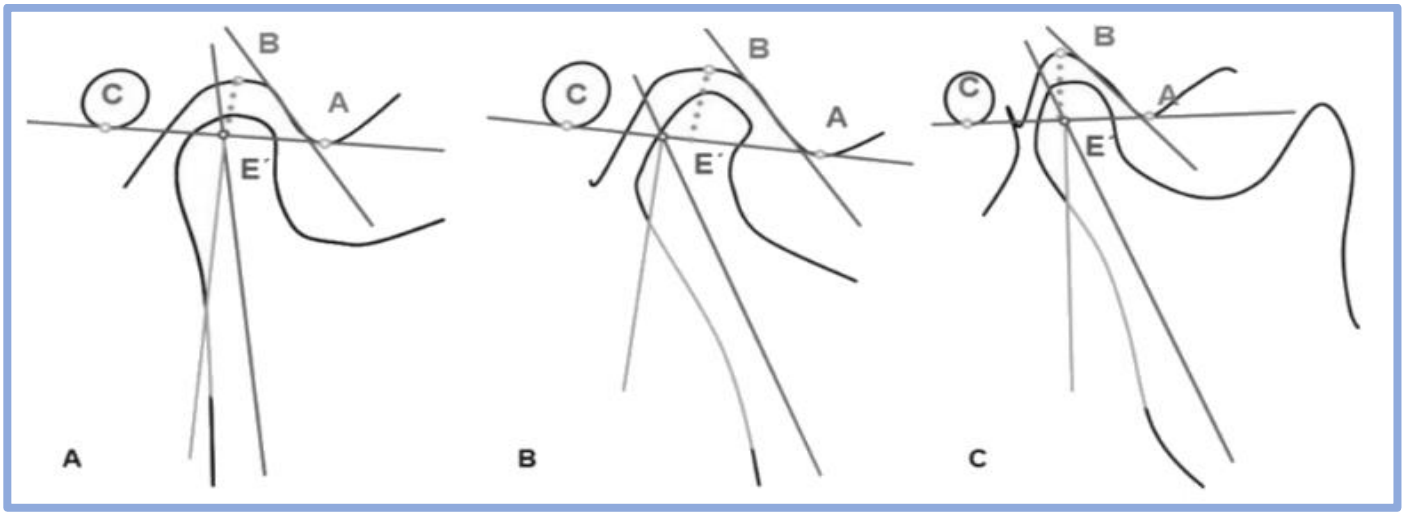


Figure 1: Schematic diagram of TMJ in para sagittal section on CBCT with Anatomic points: point A, point B and point C. Reference plane: plane passing through points A and C. Point E', intersection between the condylar axis and the reference pla ne.

Table 1. Correlations of Cone Beam Computed Tomogram interpretations with Magnetic Resonance Image interpretations.

Patients Name				CBCT		MRI					
		AGE	SEX	antero-posterior axis relationship (%)	shape of the disc in closed mouth	Shape of the Disc in open mouth	position of posterior band	position of disc	disc reducibility in open mouth	condylar marrow	effusion
xy	R	25	F	60	1	1	3	5	1	1	1
	L			60	1	1	2	4	1	1	0
xyz	R	19	M	53	1	1	3	5	1	1	0
	L			43	1	1	3	5	0	1	1

Parameters in Table 1: R = right joint, L = left joint, shape of the disc in closed/open mouth: 1=biconcave 2= deformed; position of posterior band: 1= 1o'clk,2 =12o'clk,3=11o'clk. 4=10o'clk; direction of displacement of disc :1=anterior, 2= medial, 3=lateral, 4=anteromedial, 5 anterolateral, 6=posterior; disc reducibility1=yes, 0=no;condylar marrow edema 1 = normal marrow, 2 = edematous marrow; effusion 1=yes.0=no/absent; CBCT = Cone Beam Computed Tomogram, MRI = Magnetic Resonance Imaging

Table 2. Correlations between Cone Beam Computed Tomogram interpretations with Magnetic Resonance Image interpretations in all four groups. No significant differences were found.

		Normal (45-46%)		47-53 %		54-58 %		Above 59 %		Total		statistic	p
		n	%	n	%	n	%	n	%	n	%		
Shape of the disc in the closed mouth	1	7	11.50%	8	13.10%	14	23.00%	7	11.50%	36	59.00%	4.4	0.23
	2	4	6.60%	12	19.70%	6	9.80%	3	4.90%	25	41.00%		
	Total	11	18.00%	20	32.80%	20	32.80%	10	16.40%	61	100.00%		
Shape of the disc in the open mouth	1	7	11.50%	12	19.70%	15	24.60%	7	11.50%	41	67.20%	1.23	0.8
	2	4	6.60%	8	13.10%	5	8.20%	3	4.90%	20	32.80%		
	Total	11	18.00%	20	32.80%	20	32.80%	10	16.40%	61	100.00%		
Position of posterior band	1	0	0.00%	2	3.30%	1	1.60%	0	0.00%	3	4.90%	5.83	0.78
	2	2	3.30%	4	6.60%	5	8.20%	1	1.60%	12	19.70%		
	3	6	9.80%	5	8.20%	9	14.80%	5	8.20%	25	41.00%		
	4	3	4.90%	9	14.80%	5	8.20%	4	6.60%	21	34.40%		
	Total	11	18.00%	20	32.80%	20	32.80%	10	16.40%	61	100.00%		
Position of disc	1	4	6.60%	8	13.10%	4	6.60%	5	8.20%	21	34.40%	5.61	0.8
	2	1	1.60%	2	3.30%	1	1.60%	0	0.00%	4	6.60%		
	4	4	6.60%	6	9.80%	9	14.80%	2	3.30%	21	34.40%		
	5	2	3.30%	4	6.60%	6	9.80%	3	4.90%	15	24.60%		
	Total	11	18.00%	20	32.80%	20	32.80%	10	16.40%	61	100.00%		
Condylar marrow	1	9	14.80%	15	24.60%	19	31.10%	8	13.10%	51	83.60%	3.4	0.35
	2	2	3.30%	5	8.20%	1	1.60%	2	3.30%	10	16.40%		
	Total	11	18.00%	20	32.80%	20	32.80%	10	16.40%	61	100.00%		
Effusion	0	6	9.80%	8	13.10%	12	19.70%	3	4.90%	29	47.50%	3.15	0.36
	1	5	8.20%	12	19.70%	8	13.10%	7	11.50%	32	52.50%		
	Total	11	18.00%	20	32.80%	20	32.80%	10	16.40%	61	100.00%		
Disc Reducibility	0	3	4.90%	10	16.40%	5	8.20%	3	4.90%	21	34.40%	3.11	0.43
	1	8	13.10%	10	16.40%	15	24.60%	7	11.50%	40	65.60%		
	Total	11	18.00%	20	32.80%	20	32.80%	10	16.40%	61	100.00%		

Statistical analysis

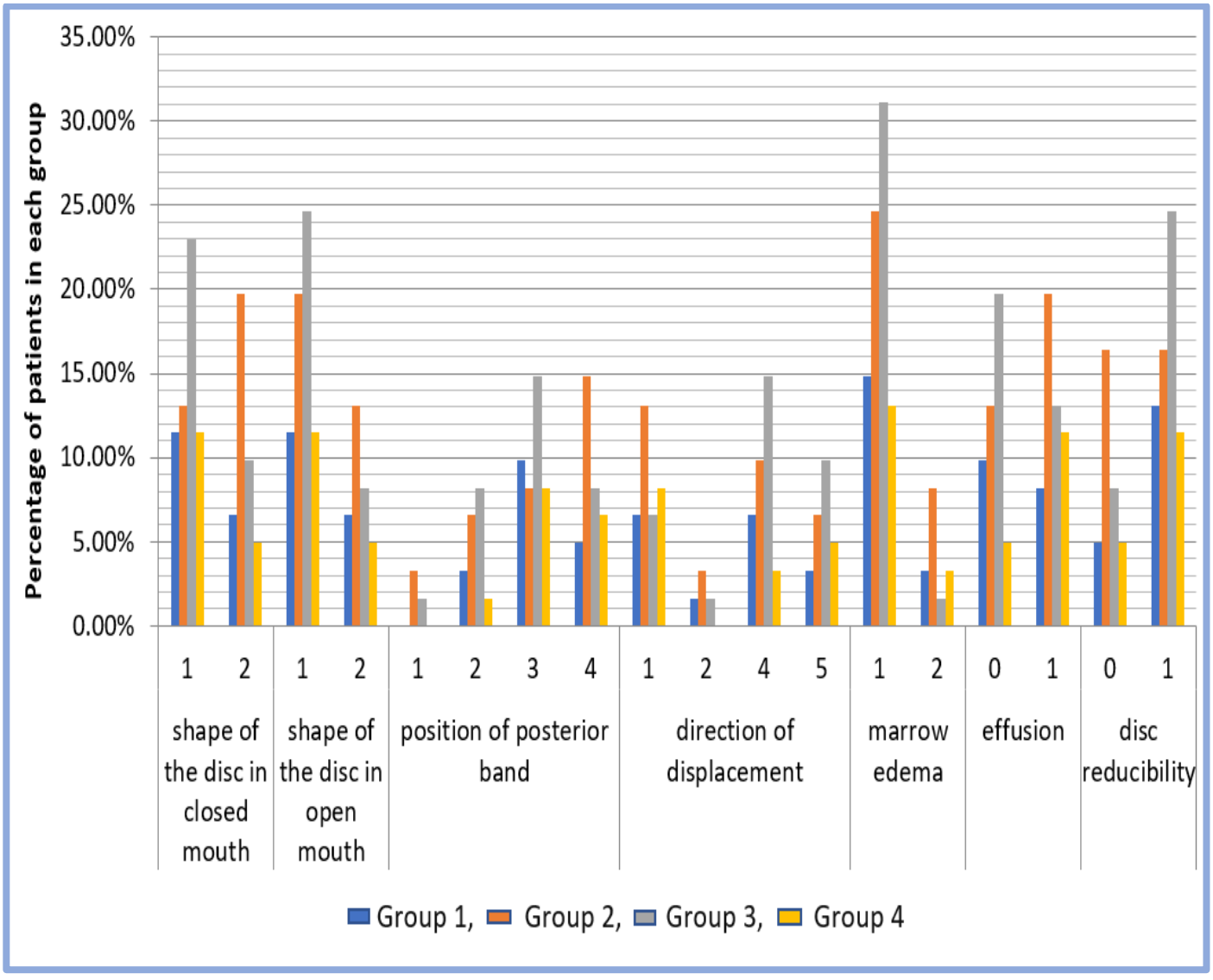
Statistical analysis was performed using a commercially available statistical software program (SPSS 19.0, IBM, Armonk, NY, USA). The correlations between the variables (E.g. CBCT and MRI indications) were explored by using the Fischer's exact test and the Chi-square test at significance level of P given in Table 2.

Results

In the study, 29 out of 34 (85.3%) patients were female patients with the mean age of 23.1 years. Male patients accounted for another 14.7 percent with the mean age of 22.8 years. A total of 61 joints were analysed and the mean condylar position Anteroposterior relationship was 52.79±5.78 (%). Four groups were formed according to the cephalometric Anteroposterior Relationship: Group I- <46%, Group II - 46-53%, Group III – 54-58%, Group IV - >59%. The numbers of patients in Group 1 to Group 4 were 11, 20, 20, and 10 respectively.

The study demonstrated high frequency of deformed disc in open and closed mouth in Group II followed by group III. See **Graph 1** and **Table 2.** Partial displacement (identified by position of posterior band) of disc was more in group III followed by group II, while complete displacement was seen more in Group II. See **Graph1** and **Table 2**. Maximum discs were displaced either anteriorly or anteromedially. See **Graph 1** and **Table 2.** Condylar marrow edema and effusion were maximum in Group II. See **Graph 1** and **Table 2.** Statistical evidence does not support any correlation between the Anteroposterior Relationship and any of the MRI variables. **See Table 2.**

Graph 1. Shows comparison between different Group (I-IV) for different Magnetic Resonance Image (MRI) parameters.



Discussion

Various epidemiological studies have documented greater frequency and severity of TMDs in females.[18, 19] Most of the patients in this study were females, with male to female ratio of 1:6. This ratio is consistent with previous studies.

Traumatic Intra-articular pathologies of the Temporomandibular joint might involve both hard and soft tissue structures. When it involves hard tissue structure like condylar head, may lead to alterations and manifest as change in shape or position of the condyle. As a consequence of trauma, soft tissue structure such as the articular disk can also suffer a displacement (partial or complete) or a perforation. This could be associated with or without a ligament injury.

Considering the spatial relationship of condyle within the glenoid fossa, according to various studies, centric position of the condyle in the glenoid fossa has been considered an optimal position,[20-25] while few authors finds it to be variable.[26, 27] Hence, alteration in the condylar position in the glenoid fossa may indicate a pathology. A study done by Learreta et al[17] on the spatial relationship of the mandibular condyle showed, those joints in a posterior position with alterations in the axis orientation of condyle, had a mean Condylar antero-posterior relationship to be 54.27% as compared to 46.30% in group without alterations in the axis orientation. In the present study, mean of the condylar Anteroposterior relationship was 52.79%. Also, despite having a history of trauma to the joint, only 11 patients i.e. in group I presented with normal antero-posterior relationship of the condyle in the fossa. Rest all the groups had an altered spatial relationship of the condyle in the fossa.

Various studies have demonstrated that patients with asymmetric joint spaces showed some kind of disc disorder, pain or muscle spasms on palpation,[20, 28, 29] while other studies state that, other than trauma to the jaw, potential and significant causes of change in the position of the condyle in the fossa include disc displacement (DD),[30] Disc hypertrophy,[31] Centric occlusion and centric relation discrepancy at the joint level,[32-34] excessive joint effusion,[35] and altered osseous morphology of the condyle and eminence due to degenerative joint disease [36] as well. This suggests that the position of the disc, (the posterior band of it in particular), has a great bearing on condylar position in the fossa.

A study done by K Ikeda et al [30] which showed that, in case of partial disc displacement(PDD), the condyles were displaced posteriorly in the fossae with a mean anterior space of 2.7 ± 0.5 mm (normal 1.3 ± 0.2 mm) and a posterior space of 1.8 ± 0.4 mm (normal 2.1 ± 0.3 mm). In total disc displacement without reduction (TDDWR), the condyles were displaced not only posteriorly as observed in PDD, but also vertically with a reduced superior space of 1.9 ± 0.4 mm (normal 2.5 ± 0.5 mm). Also, the mean posterior space in case of total disc displacement was further reduced. In the present study, partial displacement (identified by position of posterior band) of disc was more in group III followed by group II, while complete displacement was seen more in Group II (**See figure 2A-C**) and so was the disc non-reducibility and deformity in open and closed mouth. The inconsistencies in the result might be due to unequal number of joints in each group.

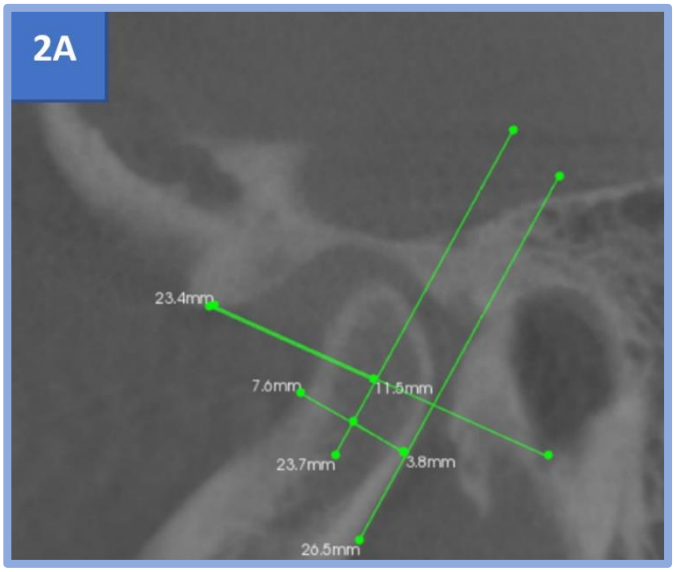


Figure 2A. Cone Beam Computed Tomogram image showing closed mandibular head sagittal view with cephalometric Anteroposterior Relationship of 49% (Group II).

Trauma to the mandible can induce joint effusion.[37] A study was done by Schellhas & Wilkes [38] stated excessive joint effusion as an important cause of changes in the position of the condyle in the fossa. In the present study 32/61 (52.5%) joint with history of traumatism had effusion on MR Imaging with maximum frequency in group II followed by group III>group IV.

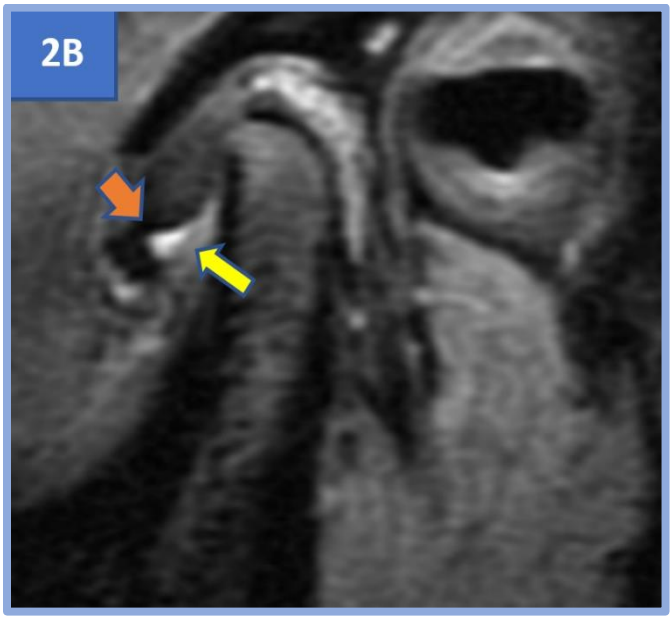


Figure 2B. Sagittal T2-weighted magnetic resonance image shows fluid effusion (yellow arrow) and anterior displacement and folded deformity of articular disc in closed mouth position (orange arrow).

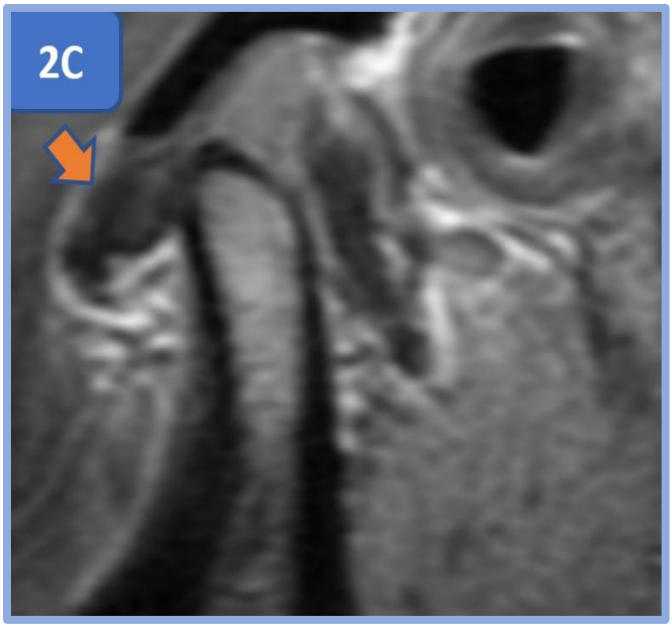


Figure 2C. Sagittal T1-weighted FSE MR Image in open mouth showing anterior displacement and folded deformity of articular disc (non-reducible disc) (orange arrow).

A study done by Emshoff et al,[39] revealed, significant relationship between the presence of TMJ bone marrow edema and the MR diagnoses of TMJ internal derangement particularly, disc displacement without reduction and effusion. Although, TMJ internal derangement alone was not always associated with bone marrow edema, it can be present without the evidence of bone marrow edema as well. The association between TMJ bone marrow edema and effusion may be supported by the fact, that the bone marrow abnormalities represent a response to an increased intra-articular pressure in conditions such as synovitis and effusion.[40,41] In the present study, Group II followed by Group III (See **Figure 3A-C**) demonstrated highest frequency of bone marrow edema, non-reducibility of disc in open mouth and effusion and hence, was consistent with the findings of previous studies.

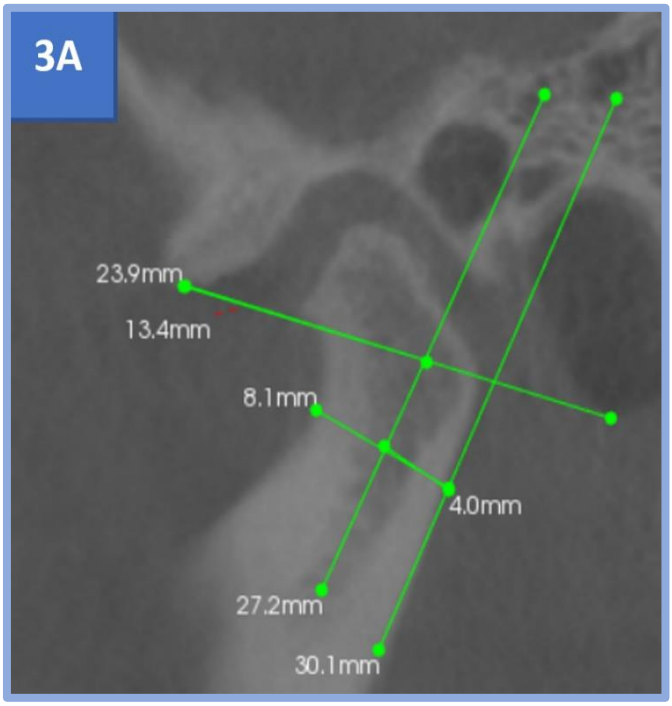


Figure 3A. A Cone Bean Computed Tomogram image showing closed mandibular head sagittal view with cephalometric Anteroposterior Relationship of 56% (Group III).

In the present study, since the CBCT spatial relationship when compared with MR imaging was not statistically significant, it would still justify the need for MR imaging to understand the orthopaedic joint position. As maximum number of patients in the study, presented with an altered spatial relationship of the condyle and had one or the other signs of internal derangement on MR imaging which makes it imperative for the clinician to advice for an MRI scan as soon as they discover an altered condylar axis change on CBCT. Also, clinicians would benefit by understanding the spatial relationship and MR imaging findings in internal derangement cases while planning for complex dental rehabilitation procedures viz full mouth reconstruction, implants and orthodontic corrections.

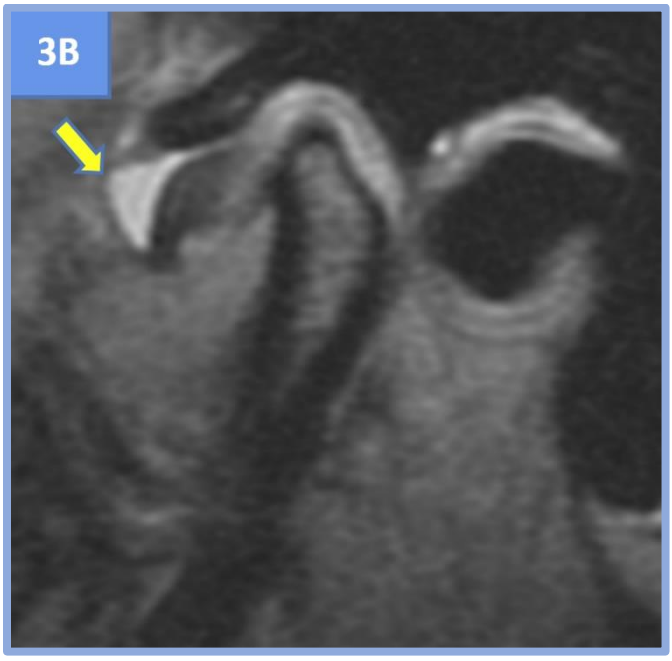


Figure 3B. Sagittal T2-weighted magnetic resonance image shows fluid effusion (yellow arrow) in superior joint cavity and anterior displacement and folded deformity of articular disc in closed mouth position.

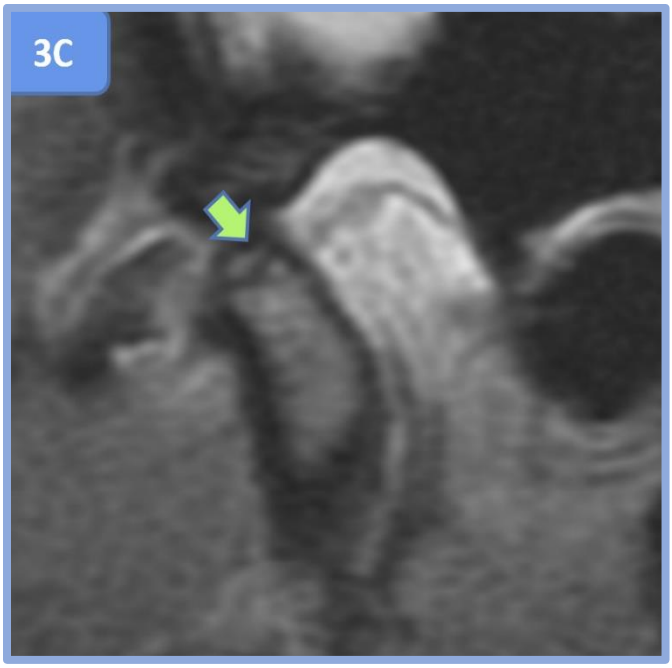


Figure 3C. Sagittal T1-weighted FSE magnetic resonance image in open mouth showing anterior displacement and folded deformity of articular disc (non-reducible disc) along with subchondral cyst. (green arrow).

Limitations

1. The study limitations included a small total sample size and fewer joints in group III and group IV. 2. The sample could have included a more heterogeneous population of TMD patients.

Conclusions:

Although, statistical evidence does not support any correlation between the Anteroposterior Relationship of condyle in the fossa on CBCT and any of the MRI variables, the results of this investigation confirm the concept that altered spatial relationship of condyle within the fossa might be related to MRI findings of internal derangement, Osteoarthrosis, and effusion. Patients should be advised of the possibility of the development of osteoarthrosis and osteoarthritis in cases of untreated traumatic TMJ arthropathy.

Statement of conflict of interest:

The authors declare no conflict of interest.

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References:

1. Learreta J: Compendiosobrepatologias de la ATM. Sao Paulo: Artes Médicas, 2003.

2. Bradley P: Injuries of the condylar region and coronoid process. In: Rowe NL,Williams JL, eds. Maxillofacial injuries.London: Churchill Livingstone, 1985.

3. Antoniades K, Karakasis D, Elephtheriades J: Bifid mandibular condyle resulting from a sagittal fracture of the condylar head. Br J Oral MaxillofacSurg 1993; 31(2):124-126.

4. Gotte P, Fraccari F: Unilateral sagittal fracture of the head of the mandibular condyle. Minerva Stomatol 1980; 29(1):51-54.

5. Yamaoka M, Furusawa K, Iguchi K, Tanaka M, Okuda D: The assessment of fracture of the mandibular condyle by use of computerized tomography. Incidence of sagittal split fracture. Br J Oral MaxillofacSurg 1994; 32(2):77-79.

6. Wu XG, Hong M, Sun KH: Severe osteoarthrosis after fracture of the mandibular condyle: a clinical and histologic study of seven patients. J Oral MaxillofacSurg 1994; 52(2):138-142.

7. Schimming R, Eckelt U, Kittner T: The value of coronal computer tomograms in fractures of the mandibular condylar process. Oral Surg Oral Med Oral Pathol Oral RadiolEndod 1999; 87(5):632-639.

8. Raustia AM, et al.: Conventional radiographic and computed tomographic findings in cases of fracture of the mandibular condylar process. J Oral MaxillofacSurg 1990; 48(12):1258-1262; discussion 1263-1264.

9. Fonseca R,Walker R. Oral and maxillofacial trauma, Part I. Illinois:W.B. Saunders Co.;1991, p. 418-35.

10. Keith DA. Surgery of the temporomandibular joint. Boston: Blackwell Scientific Publications Inc.; 1998, p. 1-46 and p. 115-69.

11. Peterson LJ, Ellis E, Hupp RJ, Tucker RM. Contemporary oral and maxillofacial surgery. St. Louis: CV Mosby Co.; 1993, p. 679-99.

12. Peterson LJ, Indresano AT, Marciani RD, Roser SM. Principles of oral and maxillofacial surgery. Part I. Philadelphia: JB Lippincott Co.;1997, p. 435-69.

13. Raustia AM, Pyhtinen J, Oikarinen KS, Altonen M. Conventional radiographic and computed tomographic findings in cases of fracture of the mandibular condylar process. J Oral Maxillofac Surg1990;48:1258-62.

14. WilliamsJL.Maxillofacial injuries. Part I,2ndedn. London: Churchill Livingstone Publications Co.;1994, p.405-70

15. Kalia V, Singh AP. Greenstick fracture of the mandible: A case report. J Indian Soc PedodPrev Dent 2008;26:32 5.

16. Defabianis P. Post traumatic TMJ internal derangement: Impact on facial growth (findings in a pediatric age group). J Clin Pediatr Dent 2003;27:297 303.

17. Learreta JA, Barrientos EE. Application of a cephalometric method to the temporomandibular joint in patients with or without alteration in the orientation of the mandibular condyle axis. Cranio. 2013;31(1):46-55. doi:10.1179/crn.2013.007.

18. Poveda Roda R, Bagan JV, Díaz Fernández JM, Hernández Bazán S, Jiménez Soriano Y. Review of temporomandibular joint pathology. Part I: classification, epidemiology and risk factors: review. Med Oral Patol Oral Cir Bucal. 2007;12:292–98.

19. Bueno CH, Pereira DD, Pattussi MP, Grossi PK, Grossi ML. Gender differences in temporomandibular disorders in adult populational studies: A systematic review and meta-analysis. J Oral Rehabil. 2018 Sep;45(9):720-729.

20. Weinberg LA: Correlation of temporomandibular dysfunction with radiographic findings. Prosthet Dent 1972; 28(5):519-539.

21. Owen AH III: Orthodontic/orthopedic treatment of craniomandibular pain dysfunction. Part 1:diagnosiswith transcranialradiographs. JCraniomandibPract 1984; 2(3):238-249.

22. Gelb H: New concepts in craniomandibular and chronic pain management. Mosby: Wolfe, 1994:274-276.

23. Ricketts RM: Provocations and perceptions in craniofacial orthopedics. Library of Congress Catalogue, Vol. 1, Book 1, Part 2. 1989:671-672.

24. Ismail YH, Rokni A: Radiographic study of condylar position in centric relation and centric occlusion. J Prosthet Dent 1980; 43(3):327-330.

25. Dumas AL, MoaddabMB,Willis HB, Homayoun NM: A tomographic study of the condyle/fossa relationship in patients with TMJ dysfunction. J CraniomandibPract 1984; 2(4):315-325

26. Blaschke DD, Blaschke TJ: Normal TMJ bony relationships in centric occlusion. J Dent Res 1981; 60(2):98-104.

27. Pullinger AG, Hollender L, Solberg WK, Petersson A: A tomographic study of mandibular condyle position in an asymptomatic population. J Prosthet Dent 1985; 53(5):706-713.

28. Farrar WB: Characteristics of the condylar path in internal derangements of the TMJ. J Prosthet Dent 1978; 39(3):319-323.

29. Mongini F: The importance of radiography in the diagnosis of TMJ dysfunctions. A comparative

evaluation of transcranial radiographs and serial tomography. J Prosthet Dent 1981; 45(2):186-198.

30. Ikeda K., Kawamura A. Disc displacement and changes in condylar position. Dentomaxillofac. Radiol. 2013;42:84227642. doi: 10.1259/dmfr/84227642.

31. Isberg A, Isacsson G, Johansson AS, Larson O. Hyperplastic soft-tissue formation in the temporomandibular joint associated with internal derangement. A radiographic and histologic study. Oral Surg Oral Med Oral Pathol 1986; 61: 32–38.

32. Hoffman PJ, Silverman SI, Garfinkel L. Comparison of condylar position in centric relation and in centric occlusion in dentulous subjects. J Prosthet Dent 1973; 30: 582–588

33. Rosner D, Goldberg GF. Condylar retruded contact position and intercuspal position correlation in dentulous patients. Part I. Three-dimensional analysis of condylar registrations. J Prosthet Dent 1986; 56: 230–239.

34. Dawson PE. A classification system for occlusions that relates maximal intercuspation to the position and condition of the temporomandibular joints. J Prosthet Dent 1996; 75: 60–66.

35. Schellhas KP, Wilkes CH. Temporomandibular joint inflammation: comparison of MR fast scanning with T1- and T2-weighted imaging techniques. AJR Am J Roentgenol 1989; 10: 589–594.

36. Öberg T, Carlsson GE, Fajers CM. The temporomandibular joint. A morphologic study on a human autopsy material. Acta Odontol Scand 1971; 29: 349–384.

37. Hettinga D L. Normal joint structures and their reaction to injury. J Orthop Sports Phys Ther. 1980;1:178–195.

38. Schellhas KP, Wilkes CH. Temporomandibular joint inflammation: comparison of MR fast scanning with T1- and T2-weighted imaging techniques. AJR Am J Roentgenol 1989; 10: 589–594

39. Emshoff R, Brandlmaier I, Schmid C, Bertram S, Rudisch A. Bone marrow edema of the mandibular condyle related to internal derangement, osteoarthrosis, and joint effusion. J Oral Maxillofac Surg. 2003;61(1):35-40. doi:10.1053/joms.2003.50006

40. Sano T, Westesson P-L, Larheim TA, et al: Osteoarthritis and abnormal bone marrow of the mandibular condyle. Oral Surg Oral Med Oral PatholRadiolEndod 91:50, 1999

41. Resnik D, Sweet DE, Madewell JE: Osteonecrosis and osteochondrosis, in Resnik D (ed): Bone and Joint Imaging. Philadelphia, PA, Saunders, 1996, pp 321-354

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