ORIGINAL ARTICLE e-ISSN: 2349-0659 p-ISSN; 2350-0964

Assessing Evaluating and Correlating the Clinical Findings of Temporomandibular Joint Pathology with Orthopantomogram and Magnetic Resonance Imaging – A Cross-Sectional Study

Vishram Singh[1], Yogesh Yadav[2], Hema Puranik A. R.[3]*, Chandrakala Agarwal[4]

Abstract

Background: Because of the anatomic complexity of the temporomandibular joint (TMJ) clinician cannot arrive at the accurate diagnosis only by clinical evaluation of TMJ hence would require some special imaging methods and techniques which would facilitate the accurate clinical diagnosis. One such imaging method is orthopantomography (OPG) of TMJ. Even though OPG has various limitations, it provides valuable information of TMJ and seems to be the primary choice of imaging modality for the diagnosis of TMJ pathologies. Magnetic Resonance Imaging (MRI) is considered to be the one of the best imaging technology to assess the soft tissue structures surrounding the TMJ and evolved as the best imaging modality for the diagnosis of disc displacement of TMJ. **Aim:** The aim of the study is to evaluate the clinical findings of the TMJ pathologies and to compare the findings of the OPG and MRI of the TMJ pathologies. **Methodology:** This is a cross-sectional observational study with comprised of multi-ethnic groups, selected from amongst those attending our dental c. Fifty subjects reporting to the Department of Oral Medicine and Radiology with TMJ pathologies were selected. Radiological bone changes were evaluated for flattening (flat bony contour deviating from normal convex form) and erosion (area of decreased density of cortical bone and adjacent subcortical bone) by OPG. After that, MRI of TMJ been taken and changes in the disk position was recorded with the help of radiologist. **Statistical Analysis:** Statistical presentation and analysis of the present study were done using the p value and Chi-square test by SPSSV20. **Results:** Result obtained from our study showed that pain was present in 28 (56%) patients and only 44% patients having chief complain other than pain such as noise in front of ear while mastication or restricted mouth opening [Table 1] Out of 28 patients with a chief complain of pain, 22 patients (78.57%) were having abnormal/flattened condylar head surface but out of 22 patients with a chief complain other than pain 18 patients (81.82%) were having abnormal/flattened condylar head surface [Table 2]. Out of 28 patients with a chief complain of pain, 18 patients (64.28%) were with an shortened condylar neck and also out of 22 patients with a chief complain other than pain 16 patients (72.72%) were having shortened condylar neck. The result showed statistically non-significant ($P > 0.05$) [Table 3]. Results also showed that 40% patients with Anterior Disc Displacement With Reduction (ADDR) and 50% with Anterior disc displacement without reduction (ADDWR) had abnormal condylar head surface [Table 4]. About 47.05% patients with ADDR and 41.17% with ADDWR had abnormal condylar neck [Table 5]. Even though there was a positive correlation between the OPG and MRI findings of the TMJ pathologies with the clinical findings of TMJ pathologies, result was not statistically significant which might be due to the reduced sample size. **Conclusion:** Based on the observation, it can be concluded that OPG and MRI provide valuable information regarding the temporomandibular disorders (TMD) and can play a key role in arriving at accurate clinical diagnosis of complex TMJ pathologies. It also makes the clinical diagnosis easy by correlating the clinical findings of the TMD with this imaging modality and helps clinician to arrive at the proper diagnosis and treatment plan at the earliest. This type of studies should be done on large scale in future based on specific parameters for early diagnosis and treatment planning for patients suffering with TMD to provide quality treatment to the patients at initial stage.

Asian Pac. J. Health Sci., (2021); DOI: 10.21276/apjhs.2021.8.3.8

Introduction

Temporomandibular joint (TMJ) is one of the most interesting and complex synovial systems in the body. It is where a mobile mandible articulates with the fixed cranium.[1] All these movements are regulated by an intricate neurological controlling mechanism, which is important for the system to function normally and efficiently. The TMJ is the articulation between the condyle head and the squamous portion of the temporal bone in the skull base and articular disc is present between these two bony surfaces which gives cushioning effect,[2-6] The articular disc is a fibrous capsule present in between the two bones of the joint. All of these mandibular maneuvers may occur during mastication and are regulated by a combination of neurological control mechanisms together with complex muscle systems (muscles of mastication) that react to the nervous stimuli. However, disorientation in mobility may occur by muscular dysfunction or decreased movement of the articular disc which may limit certain TMJ movements and can pose risk for TMJ dysfunction.[7]

[1]Department of Anatomy, Adjunct Faculty, Kasturba Medical College, MAHE University, Mangalore, Karnataka, India, [2]Department of Anatomy, Santosh Medical College, Santosh Deemed to be University, Ghaziabad, Uttar Pradesh, India, [3]Sri Siddhartha Medical College , SAHE University, Tumkur, Karnataka, [4]Department of Anatomy, SMS Medical College, Jaipur, Rajasthan

Corresponding Author: Dr. Hema Puranik A. R., Department of Anatomy, Siddhartha Medical College, SAHE University, Tumkur, Karnataka, India

How to cite this article: Singh V, Yadav Y, Puranik ARH, Agarwal C. Assessing Evaluating and Correlating the Clinical Findings of Temporomandibular Joint Pathology with Orthopantomogram and Magnetic Resonance Imaging – A Cross-Sectional Study. Asian Pac. J. Health Sci., 2021;8(3):34-38.

Source of support: Nil

Conflicts of interest: None.

Received: 10/02/2021 **Revised:** 22/04/2021 **Accepted:** 20/05/2021

Temporomandibular disorders (TMD) is collection of clinical problems involving the muscles of mastication, the TMJ, surrounding hard- and soft-tissue components, and occurrence of any of these problems.[8] TMD is considered to have a multifactorial etiology which could be due to muscle hyper function or parafunction, traumatic injuries, hormonal influences, and articular changes within the joint. Although the clinical examination is the most important step in the diagnosis of TMJ pathology, special imaging techniques are needed due to the complex anatomy and pathology. Panoramic radiography is also an good imaging technique for the TMD. Panoramic radiography can help evaluate the following:

- Degenerative bone changes (only in late stages; it is inadequate for the early detection of osseous modifications)
- Asymmetries of the condyles.

The panoramic radiography does not reveal the functional status of the joint and has a relatively low specificity and sensitivity when compared with computed tomography (CT).[9,10]

Table 1: Distribution of chief complain of the patients

Chief complain	*No.*	*Percentage*
Pain	28	56
Other	22	44
Total	50	100

Table 2: Distribution according to Condylar head surface and chief complain of pain

Condylar head surface	*Chief complain of pain (%)*		*Total (%)*
	Present	*Absent*	
Abnormal	22 (78.57)	18 (81.82)	40 (80)
Normal	6 (21.43)	4 (18.18)	10 (20)
Total	28 (56)	22 (44)	50 (100)

Chi square test=0.04058, *P*=0.8403

Table 3: Distribution according to Condylar Neck and chief complain of pain

Condylar neck	*Chief complain of pain (%)*		*Total (%)*
	Present	*Absent*	
Abnormal	18 (64.28)	16 (72.72)	34 (68)
Normal	10 (35.72)	6 (27.28)	16 (32)
Total	28 (56)	22 (44)	50 (100)

Chi square test=0.2017, *P*=0.6533

Magnetic resonance imaging (MRI) is currently considered the reference method for imaging the soft-tissue structures of the TMJ (articular disc, synovial membrane, and lateral pterygoid muscle) and has been pointed out as the best imaging modality in diagnosing disc displacements.[11,12] MRI could also detect the early signs of TMJ dysfunction, such as thickening of anterior or posterior band, rupture of retrodiscal tissue, changes in shape of the disc, and joint effusion.[7]

The current study was a cross-sectional observational study aimed at investigating a possible correlation between the clinical findings of TMJ pathologies with the images of orthopantomography (OPG) and MRI.

Aim

The aim of the study is to evaluate the clinical findings of TMJ pathologies and to compare the findings of OPG and MRI images of TMJ pathologies.

Methodology

The study was conducted among the out patients with TMJ problem visiting to the Department of Periodontology, Jaipur Dental College.

Research Design and Study Population

Ethical clearance for the study was obtained from ethical committee of the institution. Patients selected for the study were explained in detail about the condition affecting their oral cavity and the procedure that they would be subjected to. A written informed consent was sought from all of them.

The cross-sectional observational study consisted of multi-ethnic groups, selected from among those attending outpatient department (OPD). Fifty subjects reporting to the OPD with TMJ pathologies were selected. OPG was advised and radiological bone changes were evaluated for flattening (flat bony contour deviating from normal convex form) and erosion (area of decreased density of cortical bone and adjacent subcortical bone). MRI of TMJ was done and changes in the disk position were recorded with the help of radiologist.

Table 4: Comparison of OPG finding (condylar head surface) with MRI finding (disc position)

Condylar head surface	*Disc position*						*Normal (%)*
	ADDR (%)			*ADDWR (%)*			
	Right	*Left*	*Total*	*Right*	*Left*	*Total*	
Abnormal (*n*=40)	8 II (20.0)	8 (20.0)	16 (40.0)	6 (15.0)	14 (35.0)	20 (50.0)	10 (25.0)
Normal (*n*=l0)	0 II (0.0)	0 (0.0)	0 (0.0)	2 (20)	0 (0.0)	2 (20)	8 (80)
Total (*n*=50)	8 (16)	8 (16)	16 (32)	8 (16)	14 (28)	22 (44)	18 (36)

Chi square test (Abnormal vs. Normal) =5.25, *P*>0.05. OPG: Orthopantomography, MRI: Magnetic resonance imaging, ADRR: Anterior disc displacement with reduction, ADDWR: Anterior disc displacement without reduction

Table 5: Comparison of OPG finding (condylar neck shortening) and MRI finding (disk position)

Condylar neck	*Disc position*						*Normal (%)*
	ADDR (%)			*ADDWR (%)*			
	Right	*Left*	*Total*	*Right*	*Left*	*Total*	
Abnormal (*n*=34)	10 (29.41) II	6 (17.64)	16 (47.05)	4 (11.76)	10 (29.41)	14 (41.17)	8 (23.52)
Normal (*n*=16)	0 (0.0)	0 (0.0)	0 (0.0)	4 (25)	4 (25)	8 (50)	10 (62.5)
Total (*n*=50)	10 (20)	6 (12)	16 (32)	8 (16)	14 (28)	22 (44)	18 (36)

Chi-square test (Abnormal vs. Normal) =3.586, *P*>0.05. OPG: Orthopantomography, MRI: Magnetic resonance imaging, ADRR: Anterior disc displacement with reduction, ADDWR: Anterior disc displacement without reduction

Inclusion Criteria

Subjects aged between 25 and 40 years complaining of TMJ pain during palpation or function, or restricted mouth opening or clicking observed from past 6 months with no systemic disease history or developmental anomaly were included in the study.

Exclusion Criteria

Subjects with recent history of ear infection, claustrophobia, uncooperative, pregnant or with pace makers, aneurysm clips, partial dentures, hearing aids, metallic implants, and crowns were excluded from the study.

Method of Collection of Data

Data collection included detailed history, clinical examination, OPG, and then MRI examination of TMJ.

The study obtaining detailed case history of patients with TMJ problem with special focus on the following factors:

- Duration of TMJ problem
- Previous history of such problem/with treatment at that time
- Medical history
- Family history
- Habits
- Stress history

Panoramic Radiograph

Panoramic radiograph was taken for those patients as a screening radiograph. Imaging was carried out with rotograph plus with 5A current and 17s exposure time for bilateral TMJ. Data were collected on digital X-ray sheet. Proper patient positioning was done by making the patients to bite on bite block and also by keeping central and lateral indicator at correct position. All the OPG were taken in standing position.

MRI

Bilateral TMJ MR images were obtained of all patients included in the study even though if patient complaint only in one joint so that other joint images were used for comparison. MR images were taken by means of 1.5T MR scanners (GE Scanner) and a dedicated circular polarized transit and receive Head coil for TMJ. The data were collected on a 256 × 192 matrix with a field view of 12 mm. Axial localizing images were taken from which the sagittal and coronal planes were described. The maximum intercuspation position was used for close mouth images. After the closed-mouth image was obtained, the patient was instructed to open the mouth as wide as possible to obtain reduction of a displaced disc. Pulse sequence was obtained on sagittal and coronal T1-weighted images, T2-weighted images, proton density images, and Gradient Echo weighted images.

The position of the disc was diagnosed by a single radiologist and same MR unit for all the patients as there would be less variation. The position of disc was diagnosed as:

- Normal: When the disc was located superior to the condyle both in closed and open mouth position
- Disc displacement with reduction: when the disc was displaced at the closed mouth position and in the normal position in the open-mouth images
- Disc displacement without reduction: When the disc was displaced in both the closed and open mouth positions,

On T1-weighted images, normal anatomy was identified and disc position on sagittal and coronal plane.

Statistical Analysis

Statistical presentation and analysis of the present study were done using the *P*-value and Chi-square test by SPSSV20.

Results And Observation

Fifty subjects reporting to the dental OPD with TMJ pathologies were selected and evaluated clinically. After that OPG and MRI of TMJ been taken and from MRI, changes in the disk position were recorded with the help of radiologist. From the OPG images radiological bone changes were evaluated for flattening (flat bony contour deviating from normal convex form) and erosion (area of decreased density of cortical bone and adjacent subcortical bone).

- Result obtained from our study showed that pain was present in 28 (56%) patients and only 44% patients having chief complain other than pain such as noise in front of ear while mastication or restricted mouth opening [Table 1]
- Out of 28 patients with a chief complain of pain 22 patients (78.57%) were having abnormal/flattened condylar head surface but out of 22 patients with a chief complain other than pain 18 patients (81.82%) were having abnormal/flattened condylar head surface [Table 2]
- Out of 28 patients with a chief complain of pain 18 patients (64.28%) were with a shortened condylar neck and also out of 22 patients with a chief complain other than pain 16 patients (72.72%) were having shortened condylar neck. The result showed statistically non-significant ($P > 0.05$) [Table 3]
- Results also showed that 40% patients with Anterior Disc Displacement With Reduction (ADDR) and 50% with ADDWR (Anterior Disc Displacement without Reduction) had abnormal condylar head surface [Table 4]
- 47.05% patients with ADDR and 41.17% with ADDWR had abnormal condylar neck [Table 5].

The above table depicts that the most common chief complaint was pain in 56% of patients and only 44% patients having chief complain other than pain like noise in front of ear while mastication or restricted mouth opening.

Out of 28 patients with a chief complain of pain, 22 patients (78.57%) were having abnormal/flattened condylar head surface but out of 22 patients with a chief complain other than pain 18 patients (81.82%) were having abnormal/flattened condylar head surface.

Out of 28 patients with a chief complain of pain, 18 patients (64.28%) were with an abnormal/shortened condylar neck and also out of 22 patients with a chief complain other than pain 16 patients (72.72%) were having abnormal/shortened condylar neck.

The result showed statistically non-significant ($P > 0.05$).

Table shows 40% patients with ADDR and 50% with ADDWR had abnormal condylar head surface and only 0% patients with ADDR and 20% patients with ADDWR had normal condylar head surface which shows correlation between these two exist but results are not statistically significant.

Table shows 47.05% patients with ADDR and 41.17% with ADDWR had abnormal condylar neck and only 0% patients with ADDR and 50% patients with ADDWR had normal condylar neck which shows correlation between these two exist but results are not statistically significant.

Discussion

The present study was conducted to evaluate the TMJ pathologies clinically and to correlate it with the OPG and MRI findings. A total of 50 subjects reporting to the department of periodontology with TMJ pathologies were selected. All the individuals were evaluated clinically for TMD and were subjected to OPG and MRI. In OPG findings such as condylar head flattening and condylar head shortening were evaluated and from MRI images disc position was evaluated. The findings of OPG and MRI were then compared.

The TMJ is a hinge type of synovial joint that allows both protrusive and retrusive translation as well as a gliding motion.[3] TMD is a collection of broad group of clinical problems involving the soft-tissue and hard-tissue component surrounding the joint.[8]

Panoramic radiography serves as a primary diagnostic modality for TMJ imaging.[13] Even though the structural abnormalities of the condyle can be visualized with panoramic radiography, they do not necessarily provide accurate clinical diagnostic information of TMD because of the overlapping of surrounding anatomic structures and anatomic complexity of the joint.[14] MRI is considered as the gold standard for the visualization of the soft tissues of the TMJ and can detect the signs of TMJ dysfunction at the earliest, such as thickened anterior or posterior band, distortion or disintegration of retrodiscal tissue, alteration of the disc morphology, and joint effusion. Hence, to get the basic valuable information of OPG, in this study, both MRI and OPG was used to know whether there is any correlation between clinical sign and symptoms of TMJ disorders with that of changes of joint as observed in OPG and MRI and to arrive at accurate clinical diagnosis by getting the information from both the imaging modalities.

The results obtained from this study have showed that symptoms of pain were present only in 28 (56%) patients and 44% patients having chief complain other than pain like noise in front of ear while mastication or restricted mouth opening. Out of 28 patients, 10 (20%) patients had pain on right side, eight (16%) patients had on left side and 18 (36%) had pain occurred bilaterally. The results obtained in our study were in accordance with the study done by Kumar *et al*. (2015)[14] who found that 4 (18.2%) were clinically diagnosed as Bilateral TMD, 12 (54.5%) were clinically diagnosed as Left TMD, and 6 (27.3%) were clinically diagnosed as right TMD.

Truta *et al*. (1990) suggested that TMJ disorders comprising of myofascial pain and dysfunction may be included in the broad group of non-specific generalized muscular aches and pains affecting other muscle groups in the body.[15]

All the subjects were subjected to OPG. A total of 22 subjects (78.57%) out of 28 who were symptomatic (pain) had condylar head flattening and 64.28% patients had condylar neck shortening. However, these changes in the OPG were also observed in 81.82% of patients whose chief complaint was other than pain. This shows no correlation between these two parameters.

The results obtained in our study were in accordance with the study done by Crow *et al*. who concluded that even though morphological abnormalities of the condylar changes can be evaluated with panoramic radiography, they does not clearly represent a sign of TMD.[14]

Epstein *et al*.[16] suggested that the clinical findings of TMD provide a clinician with the greater relevance than panoramic images for patients with TMD. Another study done by Dahlström and Lindvall.[17] concluded that panoramic radiography is useful in detecting hard tissue changes of the condyle, but when these changes are present and the radiography is normal, then CT will give more clear picture of the underlying condition.

All the individuals were subjected for MRI and changes were evaluated for disc displacement and it was found that disc displacement was present in 57.14% of symptomatic (with pain) patients and 72.72% of asymptomatic (other than pain) patients.

The result obtained in our study was in accordance with the study done by Maizlin *et al*. (2010)[18] Disk displacement was found in 45 (54%) of the 84 symptomatic joints and 13 (22%) of the 60 asymptomatic joints. Among the 84 symptomatic joints, 31 (37%) had disk displacement with reduction and 14 (17%) had disk displacement without reduction.

The results obtained were contradictory to the study conducted by Kumar *et al*. (2015)[19] who concluded that disc displacement was found to more in the patient with pain and asymptomatic patients have lesser prevalence of disc displacement.

Kumar *et al*. (2015)[19] concluded that disk displacement on MRI correlated well with the presence or absence of clinical signs and symptoms of TMD with high sensitivity and specificity of 90% and 83.3%, respectively.

When both the findings obtained from MRI and OPG were correlated it was seen that 40% patients with ADDR and 50% with ADDWR had abnormal condylar head surface and only 0% patients with ADDR and 20% patients with ADDWR had normal condylar head surface which shows correlation between these two exist but results are not statistically significant.

The results also showed that shows 47.05% patients with ADDR and 41.17% with ADDWR had abnormal condylar neck and only 0% patients with ADDR and 50% patients with ADDWR had normal condylar neck which shows correlation between these two exists but results are not statistically significant.

Frequency of condylar head flattening and neck shortening on panoramic radiography is more prevalent with anterior disc displacement (8/15) in MRI and even out of ADDR and ADDWR more prevalence was present with ADDWR.

Even though there was a positive correlation between the OPG and MRI findings of the TMJ pathologies with the clinical findings of TMJ pathologies, result was not statistically significant.

The results obtained in our study were in contradiction with the study done by Augusto *et al*.[20] who concluded that there was no association between the vertical mandibular height obtained from OPG and results of disc displacement obtained from MRI.

Yang *et al*. (2017)[21] concluded that MRI has proved to be a valuable imaging modality to evaluate multiple morphological changes at different mouth positions of normal volunteers and patients. The relationship between the disc and the condyle can serve as an important parameter for evaluating anterior disc displacement and can be used to differentiate disc displacement with or without reduction.

Thus, the findings obtained from the OPG of condylar head flattening and condylar neck shortening have positive correlation with the disc displacement of TMJ evaluated with MRI. Although there is a positive correlation between the findings of MRI and TMJ, the results are not statistically significant, which might be due to the small sample size.

Conclusion

Based on the observation, it can be concluded that OPG and MRI provide valuable information regarding the TMD and can play a

key role in arriving at accurate clinical diagnosis of complex TMJ pathologies. It also makes the clinical diagnosis easy by correlating the clinical findings of the TMD with this imaging modality and helps clinician to arrive at the proper diagnosis and treatment plan at the earliest. Long-term studies should be done on large scale in future based on specific parameters for early diagnosis and treatment planning for patients suffering with TMD to provide quality treatment to the patients at initial stage.

References

1. Symons NB. The development of the human mandibular joint. J Anat 1952;86:326-32.
2. Badel T, Savic-Pavicin I, Zadravec D, Marotti M, Krolo I, Grbesa D. Temporomandibular joint development and functional disorders related to clinical otologic symptomatology. Acta Clin Croat 2011;50:51-60.
3. Alomar X, Medrano J, Cabratosa J, Clavero JA, Lorente M, Serra I, *et al*. Anatomy of the temporomandibular joint. Semin Ultrasound CT MR 2007;28:170-83.
4. Sommer OJ, Aigner F, Rudisch A, Gruber H, Fritsch H, Millesi W, *et al*. Cross-sectional and functional imaging of the temporomandibular joint: Radiology, pathology, and basic biomechanics of the jaw. Radiographics 2003;23:e14.
5. Sava A, Scutariu M. Functional anatomy of the temporomandibular joint (II). Rev Med Chir Soc Med Nat Iasi 2012;116:1213-7.
6. Van Eijden TM, Korfage JA, Brugman P. Architecture of the human jaw-closing and jaw-opening muscles. Anat Rec 1997;248:464-74.
7. Tomas X, Pomes J, Berenguer J, Quinto L, Nicolau C, Mercader JM, *et al*. MR imaging of temporomandibular joint dysfunction: A pictorial review. Radiographics 2006;26:765-81.
8. Wadhwa S, Kapila S. TMJ Disorders: Future innovations in diagnostics and therapeutics. J Dent Educ 2008;72:930-47.
9. Ahmad M, Hollender L, Anderson Q, Kartha K, Ohrbach R, Truelove EL, *et al*. Research diagnostic criteria for temporomandibular disorders (RDC/TMD): Development of image analysis criteria and examiner reliability for image analysis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009;107:844-60.
10. Poveda-Roda R, Bagan J, Carbonell E, Margaix M. Diagnostic validity (sensitivity and specificity) of panoramic X-rays in osteoarthrosis of the temporomandibular joint. Cranio 2015;33:189-94.
11. Liedberg J, Panmekiate S, Petersson A, Rohlin M. Evidence-based evaluation of three imaging methods for the temporomandibular disc. Dentomaxillofac Radiol 1996;25:234-41.
12. Bag AK, Gaddikeri S, Singhal A, Hardin S, Tran BD, Medina JA, *et al*. Imaging of the temporomandibular joint: An update. World J Radiol 2014;6:567-82.
13. Brooks SL, Westesson PL, Eriksson L, Hansson LG, Barsotti JB. Prevalence of osseous changes in the temporomandibular joint of asymptomatic persons without internal derangement. Oral Surg Oral Med Oral Pathol 1992;73:118-22.
14. Crow HC, Parks E, Campbell JH, Stucki DS, Daggy J. The utility of panoramic radiography in temporomandibular joint assessment. Dentomaxillofac Radiol 2005;34:91-5.
15. Truta MP, Santucci ET, Donlon WC. Head and neck fibromyalgia and temporomandibular arthralgia. In: Jacobson AL, Donlon WC, editors. Headache and Facial Pain. New York: Raven; 1990. p. 141.
16. Epstein JB, Caldwell J, Black G. The utility of panoramic imaging of the temporomandibular joint in patients with temporomandibular disorders. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001;92:236-9.
17. Dahlström L, Lindvall AM. Assessment of temporomandibular joint disease by panoramic radiography: Reliability and validity in relation to tomography. Dentomaxillofac Radiol 1996;25:197-201.
18. Maizlin ZV, Nutiu N, Dent PB, Vos PM, Fenton DM, Kirby JM, *et al*. Displacement of the temporomandibular joint disk: Correlation between clinical findings and MRI characteristics. J Can Dent Assoc 2010;76:a3.
19. Kumar R, Pallagatti S, Sheikh S, Mittal A, Gupta D, Gupta S. Correlation between clinical findings of temporomandibular disorders and MRI characteristics of disc displacement. Open Dent J 2015;9:273-81.
20. Augusto GL, Mario S, Mabel B, Elsa FM, Sergio A. Correlation between images for diagnosis techniques in temporomandibular disorders. J Res Pract Dent 2014;2014:507487.
21. Yang Z, Wang M, Ma Y, Lai Q, Tong D, Zhang F, *et al*. Magnetic resonance imaging (MRI) evaluation for anterior disc displacement of the temporomandibular joint. Med Sci Monit J 2017;23:712-8.