Original Article

Investigating the frequency of soft tissue calcification of the temporomandibular joint in cone beam computed tomography images in selected Iranian population from 2011 to 2016

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ABSTRACT

Soft tissue calcification of the temporomandibular joints can occur in various conditions. Synovial chondromatosis, calcium pyrophosphate arthropathy (pseudogout), and osteochondritis dissecans are known conditions associated with joint-free bodies. Gaining knowledge about the prevalence of cases such as calcification, erosion, and osteophyte can help us understand their clinical significance when they are found alone or in association with disease or other conditions. The present study aims to investigate the frequency of soft tissue calcification of the temporomandibular joints using CBCT in a selected Iranian population. A total of 253 CBCT images were collected from the joints of patients (both male and female) who visited radiology clinics in Urmia City from 2015 to 2016. CBCT images were prepared using a Planmeca Promax 3D device with kvp=90 and mat=10. The images were reconstructed using Romexis software and examined on an HP eitebook8440w monitor in a semi-dark room by two independent observers. To examine calcifications, coronal and sagittal axial sections with a thickness of 2 mm and osteophyte and erosion sections with a thickness of 1 mm were examined. The results revealed that out of a total of 253 cases that were studied, 53 cases had calcification in the temporomandibular joint soft tissue. Also, only 67 cases had erosion in the condyle. The prevalence of osteophyte in the condyle was 26 cases. None of the studied cases were associated with gender. The agreement between the two observers was high based on the Wilcoxon test and there was no significant difference. According to this study, CBCT is a suitable imaging method for examining calcifications and bone changes in the temporomandibular joint (based on the agreement of two observers). More studies are needed to confirm this result.

Keywords: Calcification, Temporomandibular joint soft tissue, Computed tomography, Erosion

Introduction

Soft tissue calcification of the temporomandibular joints can occur in different conditions. Synovial chondromatosis, calcium pyrophosphate arthropathy (pseudogout), and osteochondritis dissecans are conditions associated with free joint bodies (1). Capsules are placed in soft tissue. Joint free bodies are radiopaques of different origins located in the synovium inside the capsule, in the joint spaces, or outside the capsule in the soft tissue. They can be observed in the images as calcifications around the condyle or superimposed on it. These bodies may be osseous detached from joint components, such as that seen in degenerative joint disease, or hyaline cartilage metaplasia (calcification) that occurs in synovial chondromatosis, or crystals deposited in crystal-associated arthropathy in the joint space or tumoral calcinosis related to kidney disease (2). Disc calcifications, disc perforation, joint dysfunction, and joint degradation have been reported in some articles (3-5). Discs may occur as a result of aging or mechanical forces, all of which are possible causes of disc calcification (1).

Also, since the temporomandibular joint is used continuously throughout life, the existence of signs of erosion and damage in its bony parts or soft tissue will not be surprising. Thus, age-related degenerative changes manifested in the form of osteoarthritis are the most common joint pathological conditions (6). Bone changes in osteoarthritis include flattening of sclerosis, formation of osteophyte, erosion, condyle degradation, erosion

of the mandibular fossa, and reduction of the joint space (7). A study by Asma et al. (2013) to evaluate the prevalence and reliability of temporomandibular joint calcification diagnosis by CBCT stereotypes showed that the prevalence of calcification was 12% and 34% in the first and second observations, respectively. The chi-square test did not show a significant relationship between the first and second observations (1).

A review study was conducted by Caruso et al. to examine the anatomy of the temporomandibular joint by CBCT (8). In a study by Honey et al., CBCT images were used to observe the temporomandibular joint and compare it with panoramic radiography and linear tomography. The results of the study revealed that CBCT images provide higher precision and accuracy than joint-specific and panoramic images in diagnosing joint erosions (9). Talaat et al. (2015) investigated bone changes in the temporomandibular joint using CBCT. The results revealed that joints with osteoarthritis significantly showed more condyle surface irregularities, osteophytes, and flattening than joints without TMD. Joints with osteoarthritis had more condyle surface irregularities and osteophytes than the locked state. Joints without TMD showed more joint space than joints with osteoarthritis. CBCT findings are significantly related to TMD clinical diagnoses (10). The temporomandibular joint is a relatively difficult area for radiographic examination. Several imaging techniques (panoramic, transcranial, and tomography) have been used over the past years to examine the temporomandibular joint condition. Radiographic examinations of the temporomandibular joint are a decisive and significant factor in differential diagnosis and final diagnosis of joint diseases (11).

Panoramic, transcranial, and tomography imaging are the most extensively used radiographs in the evaluation and examination of the temporomandibular joint thanks to their availability, convenient use, relatively low dose, and low cost. Many researchers use panoramic radiography to examine the changes in the condyles. However, the joint anatomical variations along with the factors that are the result of 2D images (superimposition, radiation angle, and changes in the patient's position) question the validity of the studies (9). T-scan is a valuable tool in TMJ evaluation. CBCT has been widely used recently, especially in the maxillary and facial regions. CBCT has high reliability and is one of the most accurate imaging methods for examining TMJ bone morphology, even compared to CT (8). It provides the possibility of reconstructing images in planes parallel or perpendicular to the longitudinal axis of the condyle (11). Since erosion and osteophyte are radiographic signs of degenerative bone disease of the TMJ joint, gaining knowledge about the prevalence of these symptoms and the calcifications of the TMJ joint can be significant in early diagnosis and clinical treatment. Thus, the study aims to investigate the frequency of soft tissue calcification of the temporomandibular joints using CBCT in patients who have undergone this imaging examination for any reason.

Materials and Methods

The statistical population of the study included CBCT images of patients who were referred to radiology clinics in Urmia City and underwent temporomandibular joint imaging. Sampling was done using the convenience sampling method and the number of samples was estimated to be 253. The data collection tool is the observation of CBCT images. The observers re-evaluated 10% of the samples after two weeks. Validity and reliability were examined using the Wilcoxon test. A total of 253 CBCT images of patients (both male and female) who were referred to radiology clinics in Urmia City from 20211- to 2016 were collected. The collected images were analyzed based on the sample inclusion criteria. The images of bilateral TMJs were observed independently. The inclusion criteria should be specified in the joint images. There should be no artifacts in the images and the joint should not be broken or deformed.

TMJ images of the following subjects were excluded from the study: The presence of deformity in the TMJ joint either developmental or acquired, presence of artifacts that reduced the quality of images of the TMJ area and made the images unrecognizable. The images were prepared as a parotid sialography process. CBCT images were prepared using a Planmeca Promax 3D device with kvp=90 and ma=10. The images were reconstructed using Romexis-3.8.2 software and were examined on the eitebook8440w monitor in a semi-dark room. To examine calcifications, coronal and sagittal axial sections with a thickness of 2 mm and osteophyte and erosion sections with a thickness of 1 mm with a voxel size of 0.2 mm were examined. To correctly prepare coronal and sagittal images, these sections were reconstructed parallel and perpendicular to the condyle longitudinal axis, respectively. The images were investigated by two oral and maxillofacial radiologists. If needed, the brightness, contrast, density, magnification, thickness, and orientation of the sections were corrected.

Each joint was examined in terms of the presence or absence of soft tissue calcification and erosion and osteophyte in axial, coronal, and sagittal images in the entire thickness of the joint. In order for radiopacity to be recognized as soft tissue calcification, it should be in the TMJ area without contact with any bony structure, the radiopacity should be seen in more than one section and be larger and more radiodense than the noise caused by the surrounding structures. After observing the images completely, 10% of the samples were examined by the first and second observers to evaluate inter-observer reliability and intra-observer reliability. The data were entered into SPSS software.

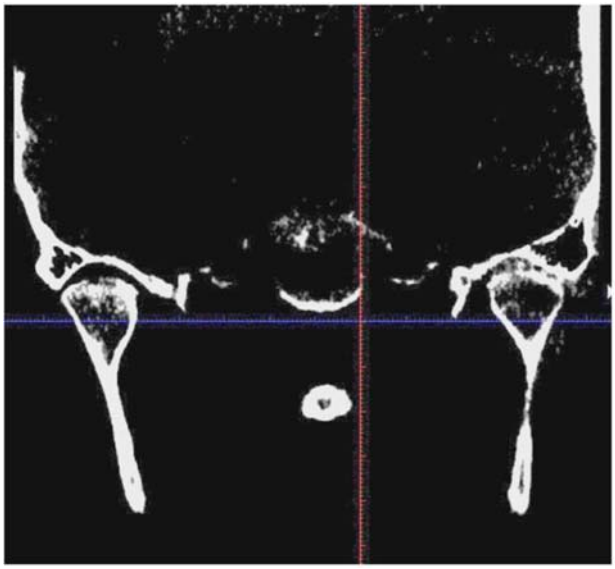

Figure 1. Coronal view displaying the presence of calcification in the soft tissue area of the left condyle

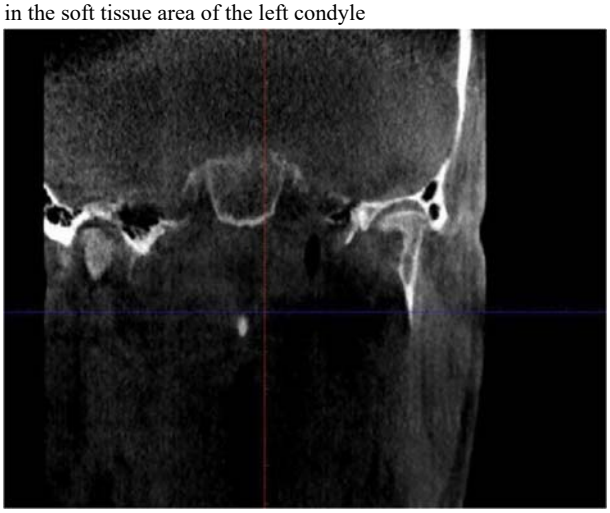

Figure 2. Coronal view displaying the presence of osteophyte in the left condyle.

Frequency distribution tables and frequency indices, percentages, means, and graphs were used to describe the data. Due to the non-normal distribution of the data, non-parametric tests such as Mann-Whitney and Wilcoxon were used for inferential statistics.

Results and Discussion

Out of 253 cases studied, 200 cases had no soft tissue calcification of the temporomandibular joint, 52 cases had soft tissue calcification of the temporomandibular joint on the left side, only 1 case had soft tissue calcification of the temporomandibular joint on the left, and right sides, and none of the cases had soft tissue calcification of the temporomandibular joints on the right side. Out of 108 males studied, 85 cases had no soft tissue calcification of the temporomandibular joint, 22 cases had soft tissue calcification of the temporomandibular joint on the left side, only 1 case had soft tissue calcification of the temporomandibular joint on the left, and right sides, and none of them had soft tissue calcification of the temporomandibular joint on the right side. Also, in females, 122 cases had soft tissue calcification of the temporomandibular joint, 22 cases of soft tissue calcification of the temporomandibular joint were on the left side, only 1 case of soft tissue calcification of the temporomandibular joint was on the left and right sides, and none of the females had soft tissue calcification of the temporomandibular joint on the left side. Also, 244 cases had no erosion in the condyle, 6 cases had erosion in the left condyle, 3 cases had erosion in the right condyle, and none of the cases had erosion in both the right and left condyles. Out of 108 males studied, 104 cases had no erosion in the condyle, 3 cases had erosion in the left condyle, only 1 case had erosion in the right condyle, and none of the cases had erosion in both the right and left condyles. Also, in females, 140 cases had no erosion in the condyle, 3 cases had erosion in the left condyle, 2 cases had erosion in the right condyle, and none of the cases had erosion in both the right and left condyle. Out of 253 cases studied, 227 cases had no osteophytes in the condyle, 25 cases had osteophytes in the left condyle, 1 case had osteophytes in the right condyle, and none of the cases had erosion lesions in both the right and left condyles. Out of 108 males studied, 104 cases had no erosion in the condyle, 3 cases had erosion in the left condyle, only 1 case had erosion in the right condyle, and none of the cases had erosion in both the right and left condyle. Also, in females, 140 cases had no erosion in the condyle, 3 cases had erosion in the left condyle, 2 cases had erosion in the right condyle, and none of the cases had erosion in both the right and left condyle.

Since the data were examined by two observers, they should be examined in terms of consistency or similarity. For this purpose, due to the non-parametric nature of the data, the Wilcoxon test was used to examine the similarity of the opinions of two observers. The mean ranks of the first observer and the degree of the second freedom statistic in calcification and osteophyte are slightly different. However, regarding erosion, they have been used similarly, as shown in Table 1 to examine the significance of this difference.

Table 1. Wilcoxon test results for observers

	Calcification	Erosion	osteophyte
Z	-1.825	0.000	-0.907
	-1.650	0.002	-0.850
Sig	0.068	1	0.365
	0.070	1	0.278

All the significance levels are greater than 0.05, so there is no significant difference between the opinions of the first and second observers and between the first and second times, and one of the two groups can be used to draw conclusions in future tests.

Table 2. Descriptive statistics of gender and calcification

	Gender	n	Mean rank	Total rank
	Male	108	133.41	14408.5

Presence of calcification	Female	145	122.22	17722.5
	Total	253		

The difference between the mean ranks of males and females is 11.19 units, and the Mann-Whitney z-statistic was used to examine the significance of this difference. Its results are shown in Table 3.

Table 3. Mann-Whitney test results for gender and calcification

	Calcification
Statistic Z	-1.706
Sig	0.088

Since the significance level is greater than 0.5, it can be concluded that there is no significant difference between males and females regarding soft tissue calcification of the temporomandibular joint on both sides (Table 3).

Table 4. Mann-Whitney test results for gender and erosion

	Erosion
Statistic Z	-0.1
Sig	0.92

Since the significance level is greater than 0.5, it can be concluded that there is no significant difference between females and males regarding erosion in the condyle on both sides (Table 4).

Table 5. Mann-Whitney test results for gender and osteophyte

	osteophyte
Statistic Z	-1.307
Sig	0.191

Since the significance level is greater than 0.05, it can be concluded that there is no significant difference between males and females regarding osteophytes in the condyle on both sides (Table 5).

Conclusion

This study was conducted retrospectively. Its samples were selected among the patients who were referred to CBCT imaging and the joint view was clear in the images. Therefore, since the samples of this study include patients who were referred to radiology clinics for various reasons such as diseases and dental conditions, they do not represent the entire population of the society. Another primary limitation of this study regarding the examination of calcifications is the absence of a gold standard in this study since the direct study and examination of TMJ is only possible through surgery. Thus, it is not possible to examine the diagnostic accuracy and reliability as indirect criteria in CBCT to evaluate calcification.

Various radiographic techniques have been used to examine the degenerative bone changes in TMJ. To examine these changes, clear and accurate images of the area are needed. However, this issue is very difficult due to the superimposition of the structures, the different angles of the condyles, and the presence of artifacts and mandible movements during imaging (12). Generally, it is difficult to examine temporomandibular joints in terms of radiography. In recent years, various techniques have been developed to evaluate the temporomandibular joint. However, there is still no single technique that can accurately image all the components of the joint. Nowadays, new and advanced techniques such as CT and MRI are mostly used for joint examination. Radiographic examination of TMJ is a vital and decisive factor in differential and final diagnoses of pathological problems and joint diseases. Conventional radiographs such as panoramic, transcranial, and transpharyngeal have limitations in examining erosions, osteophytes, sclerosis, and joint space reduction (6). Much information has not been published regarding the investigation of soft tissue calcification of the temporomandibular joints with the help of CBCT. The only similar study is related to the study by Asma et al. (2012). The mentioned study found a very poor agreement between the observers. They attributed this reason to the unreliability of the CBCT device in detecting joint soft tissue calcifications. The level of noise in the images of this device can be one of the factors that reduce the detection of small calcifications (1).

In the present study, no significant difference was seen between the observers in the examination of soft tissue, osteophyte, and erosion calcifications. The reason for the lack of differences between the observers in the present study can be attributed to the high quality of the images and low image noise, the type of CBCT device, and good training and calibration between the observers. In the present study, imaging was done with 12 mA and 90 kV. In the study by Asma, 3.8 mA was used for imaging, and the high mA in the present study can be a noise reduction factor. In the present study, the prevalence of calcification was 20.9%, erosion was 1.5%, and osteophyte was 6.5%. In the study by Asma, due to the lack of agreement between the observers, the prevalence of calcification was 12% according to the opinion of the first observer, and 34% according to the opinion of the second observer, which is different from the results of the present study. The reason for this difference may be related to the difference in the type of devices and racial differences. The prevalence of bone changes in a study by Pontul et al. was 71%. Although the prevalence of bone changes in the study by Caruso et al. was reported at 19.6% (12), the reason for the high prevalence in these studies is related to the methods of conducting studies, the high TMD, and joint symptoms in the clients of the radiology clinics.

In the present study, based on the Mann-Whitney test, no significant difference in the prevalence of calcification, osteophyte, and erosion was found between the two genders. No study has been conducted to examine the significant difference in the prevalence of calcifications in both genders. In the study by

Patual et al., the prevalence of osteoarthritis was reported at 78% in females and 22% in males (12). Also, in the study by Kohli et al. (6), it was 4 times more common in females than in males. The high rate of osteoarthritis in females can be explained by the hormonal changes of estrogen and prolactin (12). Unlike these studies, Cruzoe'-Rebello et al. showed that bone changes are equally divided between males and females and hormonal changes do not play a significant role in degenerative bone changes (12). It is similar to the present study.

It is recommended to conduct a study with a higher number of samples.

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