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Assessment of Degenerative Bone Changes in TMJ Using Conebeam Computed Tomography

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Abstract: Cone beam CT (CBCT) is a new technique for maxillofacial imaging. The aim of present study was to assess the degenerative bone changes of the condylar regarding gender and age using CBCT. A total of 100 patients who visited the dental hospital from May 2014 to March 2018 complaining of TMJ pains, TMJ sounds, or mouth opening limitation were evaluated. Conventional radiological evaluations (panoramic view and transcranial view) and CBCT examinations were performed. CBCT images of the patients were obtained using NewTom VGi scanner (QR srl; Verona, Italy) in standard resolution mode, exposure parameters include kVp=110, exposure time of 3.6 s and The primary reconstruction of the raw data was restricted to the TMJ region (approximately 4 cm superior to the mandibular fossa and 4 cm inferior, 4 cm anterior, and 3 cm posterior to the condylar neck) . Axial, Coronal and sagittal cross sections with 1mm thickness at an interval of 0.5mm were prepared. The reconstructed images were analyzed by three well-trained oral and maxillofacial radiologists. Right and left TMJs were examined separately, resulting in a total of 148 TMJs. Comparing the sagittal, coronal, and 3D images, we classified degenerative bony changes into five types: osteophytes, erosion, flattening, subchondral sclerosis, and pseudocysts. Flattening and osteophytosis were the most prevalent associations, with a 26% prevalence rate followed by flattening and erosions in 19% of patients. The prevalence of general degenerative changes significantly increased with age maximum number of degenerative changes was seen in 51 – 60 years age group. Considering the results obtained in the present study, the degenerative bone changes occurred more frequently among women and there was an increasing of alterations according the age. Flattening and osteophytosis were the most common degerative changes followed by flattening and erosions.
Keywords: Degenerative changes, Erosion, Osteophyte, sclerosis, Flattening, Psuedocyst.

INTRODUCTION

Temporomandibular joint disorders (TMDs) are considered a subdivision of musculoskeletal pathologies and are the main source of orofacial pain of non-dental origin [1]. The most common clinical signs and symptoms of TMDs are joint pain, muscle pain, mouth-opening imitation, clicking and crepitation [2]. An etiologic complex of factors such as trauma, emotional stress, muscular hyperactivity, and inflammatory and degenerative diseases may compromise the equilibrium of the temporomandibular joint (TMJ), leading to the development of temporomandibular disorder (TMD) [3]. The underlying pathogenesis of TMJ degenerative diseases is closely related to the pathological imbalance of degenerative and regenerative processes accompanied by secondary inflammatory changes on the articular surface. Once the functional load to the joint exceeds the adaptive capacity of the joint (which is affected by various individual factors such as age, gender, physical, functional, and psychosocial characteristics), histologic and morphologic changes to the joint tissue begin, resulting in typical morphological changes to the TMJ condyle including flattening, sclerosis, osteophyte formation, erosion, and subcortical bone cysts. Detection and evaluation of these bony changes are fundamental for successful diagnosis of DJD [4]. Clinical examination often fails to accurately detect degenerative bone changes and, therefore, radiographic examination is performed to aid in their diagnosis and treatment. The TMJ is a rather difficult area to investigate radiographically. A number of imaging techniques have been developed over the years; however, there is still no single technique that provides accurate imaging of all the components of the complex anatomy of the joint. Modern imaging modalities, such as MRI and CT, are now being used more frequently for radiographic examination of the TMJ. MRI is considered as one of the most useful investigations since it provides images of both soft tissue and bony components. However, the contraindications for certain types of patients and a few other disadvantages of MRI, such as long scanning time and restricted availability of the equipment, should be taken into consideration. On the other hand, CT provides images of the bony components only. However, this can be sufficient for the final diagnosis in a number of pathological conditions. Pathological changes such as formation of osteophytes, erosion, fractures, ankylosis, developmental abnormalities, as well as the position of the condyle in the fossa in open and closed-mouth conditions can be detected on CT images [5]. A main disadvantage of the CT examination still remains the high radiation dose involved. CBCT is a new technique producing reconstructed images of high diagnostic quality using lower radiation doses than normal CT. CBCT has been efficient in the diagnosis of several bone changes in the TMJ[6]. The aim of this study was to assess degenerative bone changes in the condyle with patient stratification by sex, age, and type of bony change using CBCT.

MATERIALS AND METHODS

A total of 100 patients who visited the dental hospital from May 2014 to March 2018 complaining of TMJ pains, TMJ sounds, or mouth opening limitation were evaluated. Conventional radiological evaluations (panoramic view and transcranial view) and CBCT examinations were performed. Twenty six (26) scans did not show degenerative changes in the condyle whereas 74 revealed degenerative processes.CBCT images of the patients were obtained using NewTom VGi scanner (QR srl; Verona, Italy) in standard resolution mode , exposure parameters include kVp=110, exposure time of 3.6 s and The primary reconstruction of the raw data was restricted to the TMJ region (approximately 4 cm superior to the mandibular fossa and 4 cm inferior, 4 cm anterior, and 3 cm posterior to the condylar neck) . Axial, Coronal and sagittal cross sections with 1mm thickness at an interval of 0.5mm were prepared. The reconstructed images were analyzed by three well-trained oral and maxillofacial radiologists. Right and left TMJs were examined separately, resulting in a total of 148 TMJs. comparing the sagittal, coronal, and 3D images; we classified degenerative bony changes into five types: osteophytes, erosion, flattening, subchondral sclerosis, and pseudocysts. For the accurate assessment, only the bony changes on the articular surfaces were evaluated. Condyles with hyperplasia, deviation in form, and systemic arthritis were excluded in this study. The criteria for the types of condylar bony change shows as follows:

- Erosion: an area of decreased density or discontinuity or irregularity of the cortical bone (Figure 1)
- Osteophytes: marginal bony outgrowths on the condyle (Figure 2)
- Flattening: a flat bony contour deviating from the convex form (Figure 3)
- Sclerosis: an area of increased density of cortical bone extending into the bone marrow (Figure 4)
- Pseudocysts: well-circumscribed osteolytic adjacent subcortical bone area without cortical destruction.

Fig-1: Erosion

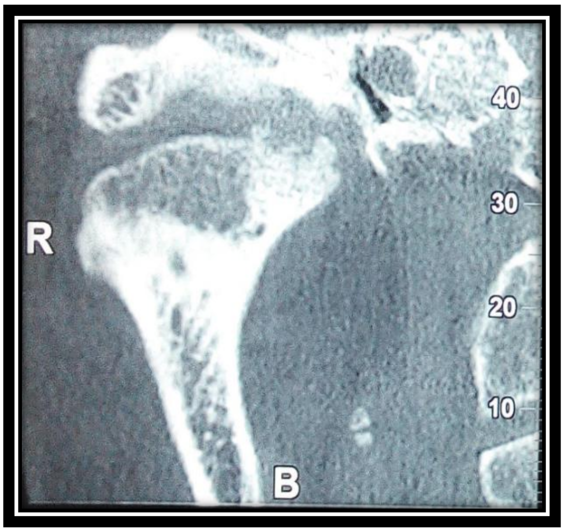


Fig-2: Osteophyte

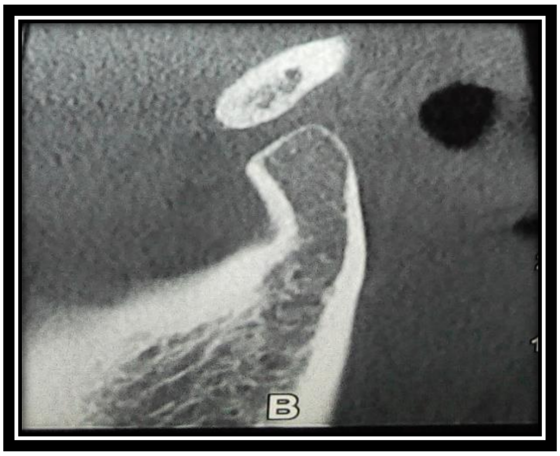


Fig-3: Flattening

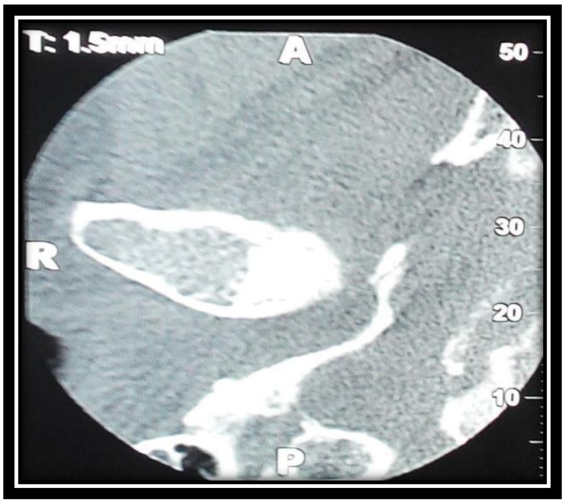


Fig-4: Subchondral sclerosis

Statistical methods

Statistical software's SPSS (Version 20.0) and Microsoft Excel were used to carry out the statistical analysis of data. Data were analyzed by means of descriptive statistics, *viz*., percentages, means and standard deviations. Graphically, the data were presented by bar diagrams and pie chart.

RESULTS

A total of 100 CBCT scans were assessed. Twenty six (26) scans did not show degenerative changes in the condyle whereas 74 revealed degenerative processes. Out of 74 patients 23 were males and 51 were females (chart no 1).

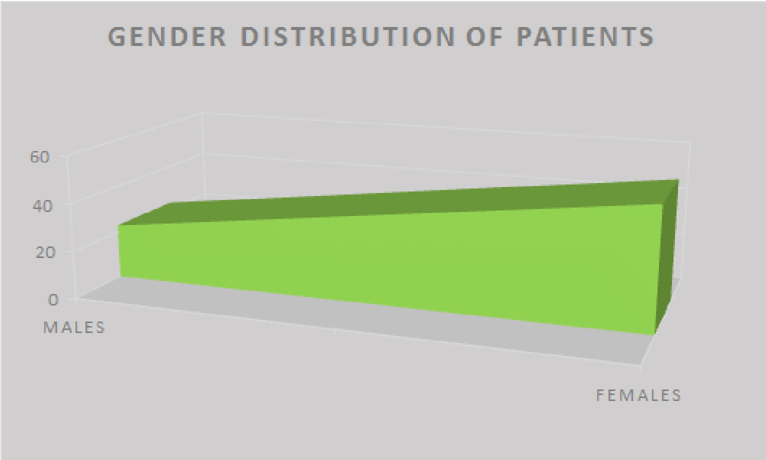


Chart no – 1

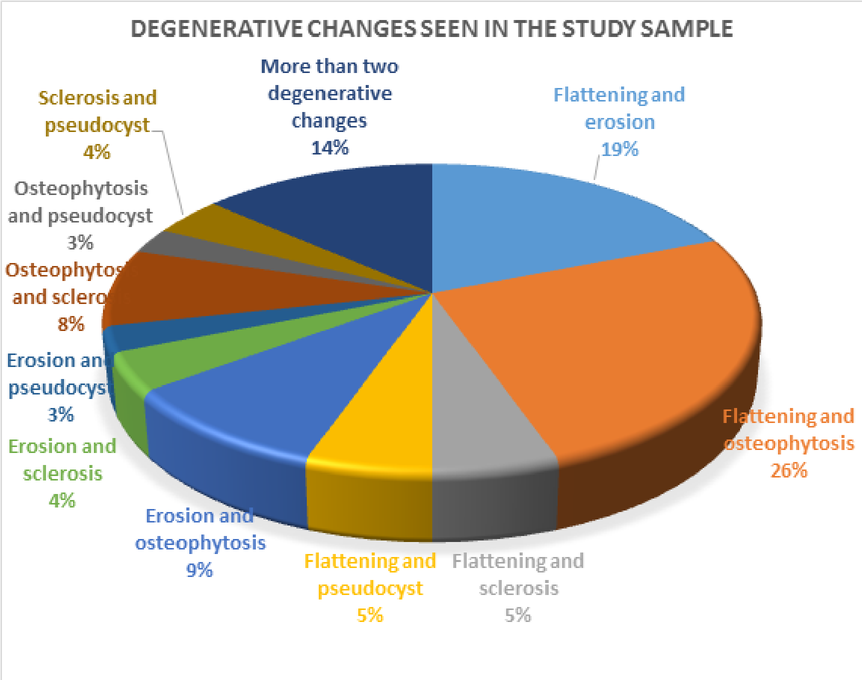
Pie chart no 2 shows the percentage of different degenerative changes in the condyle and demonstrates that flattening and osteophytosis were the most prevalent associations, with a 26% prevalence rate followed by flattening and erosions in 19% of patients.

Type of degerative change	No of Patients
Flattening and erosion	14
Flattening and osteophytosis	19
Flattening and sclerosis	4
Flattening and pseudocyst	4
Erosion and osteophytosis	7
Erosion and sclerosis	3
Erosion and pseudocyst	2
Osteophytosis and sclerosis	6
Osteophytosis and pseudocyst	2
Sclerosis and pseudocyst	3
More than two degenerative changes	10

The G test revealed that the prevalence of general degenerative changes significantly increased with age (Chart no 3).maximum number of degenerative changes were seen in 51 – 60 years age group.

DISCUSSION

The TMJ moves in a very complicated way, rotating and sliding out from the fossa simultaneously and bilaterally, this is coordinated by the masticatory muscles, ligaments, surrounding bony structures, and the neural impulses between them and the central nervous system. During such complicated movements, mostly compressive and sheering forces affect the mandibular condyle, disc and articular cartilage[7, 8]. Several radiographic methods are used to assess degenerative bone changes that affect the TMJ. It is essential to obtain a clear and precise image of the region, but this can be difficult owing to the superimposition of adjacent structures, different angulations of the condyle, limitation of mouth opening in some patients, presence of artefacts and mandibular movements during the examination [9]. Owing to the cost and the high dose of radiation, Brooks *et al*. [6] suggested that CT of the TMJ region be reserved for evaluation of foreign bodies, cell reaction to silicon or polytetrafluoroethylene sheet implants, suspected tumours, ankylosis and complex facial fractures. In a systematic literature review, Hussain *et al*. [10] observed that advances in CT have contributed to increased accuracy in the diagnosis of degenerative bone changes in the TMJ. However, this increase is not significant in relation to corrected conventional tomography [10, 11]. According to Tsiklakis *et al*. [12] and Koyama *et al*. [13] CBCT should be used instead of CT because the dose of radiation to which the patient is exposed is much lower.



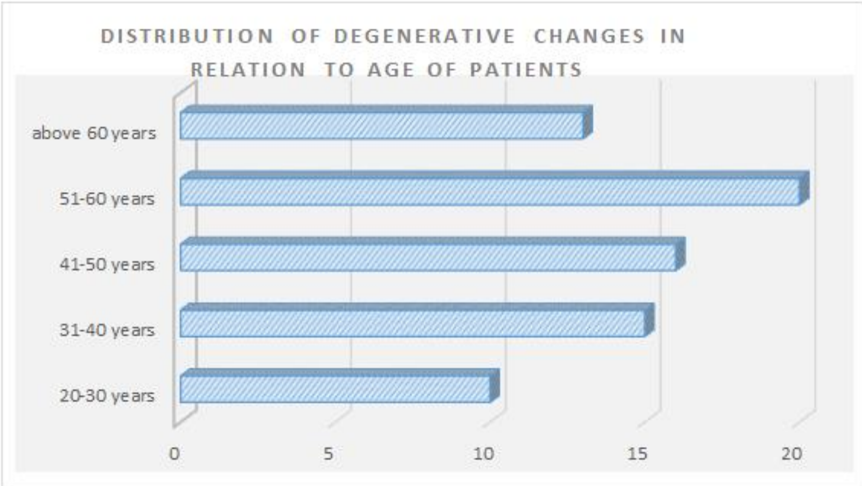


Chart no 3

Furthermore, CBCT is superior to CT for visualizing bone changes in the TMJ, analysing lateral slices in isolation and combining coronal and lateral slices [12-14]. Additionally, the CBCT scanning time of around 60 s is shorter than the time required for a conventional CT examination [15] or ACT. For instance, an exposure time of 56 s is required to take just four lateral tomograms of a single TMJ using conventional spiral tomography [16]. CBCT scan times vary somewhat between different machines and scan times may change with subsequent new versions of imaging units. Only one study has been published to date evaluating the diagnostic capabilities of CBCT in detecting erosions and osteophytes in the TMJ. Honda *et al*. [17] determined that CBCT has diagnostic capabilities equal to or greater than those of HCT. They emphasise that, due to the decreased cost and radiation dose, CBCT is a viable diagnostic alternative for detecting erosions and osteophytes in the TMJ. Using side-by-side comparison with HCT, they conclude that CBCT produced consistently superior quality images, but that there was no significant difference in detecting erosions or osteophytes. Thus, CBCT was the imaging method used in this study. The use of CBCT in this study detected a 74% prevalence of bone changes in the TMJ, which is consistent with other studies [5, 18]. The high prevalence may be attributed to the fact that the sample of patients referred to the dental radiology service had been previously examined by a dentist, with clinical symptoms or signs and/or abnormal TMJ images on previous radiographs; and because of that, CBCT was requested. According to literature reviews, degenerative bone changes in the TMJ are more frequent among women than among men. In this study, 68.9% were female and 31.1%% were male, as also reported in other studies [19, 20] Liu & Steinkeler [21] observed that TMD symptoms are more prevalent in women than in men, and that women tend to develop TMD, especially after menopause. The rationale behind the prevalence of TMD has not been elucidated yet, but the influence of hormones, mainly estrogen, has been suggested. Dibai-Filho *et al.*[22] declared that women are mostly affected by TMD owing to anatomic, biological, and hormonal factors. According to Cevidanes *et al*.[23] osteoarthritis is age-related, that is, both the progression and severity of degenerative bone changes in the condyle and in the mandibular fossa increase with age. The results of the present study evidenced a higher rate of changes as age advanced, showing that individuals older than 50 years (50-60 years) were the most affected ones, as corroborated by other studies[24,18]. Flattening and osteophytosis were the most prevalent associations, with a 26% prevalence rate followed by flattening and erosions in 19% of patients. The high prevalence of flattening and osteophytosis observed in this sample may be explained by the possibility that such finding could be an adaptive change, in addition to a degenerative change resulting from an overload on the TMJ. However, it is often difficult to radiographically distinguish advanced remodeling from degenerative joint disease. It was observed that flattening, pneumatized articular eminence, and the decrease in condylar size were likely to occur even after the signs and symptoms of TMD have resolved or been mitigated [25]. A similar result was described by Anjos Pontual *et al*.[24] who found the association between osteophytosis and flattening to be the most prevalent. Nevertheless, Oliveira *et al*.[19] concluded that erosion + osteophytosis was the most frequent association, but one should recall that those authors did not include flattening in their study.

CONCLUSION

Considering the results obtained in the present study, the degenerative bone changes occurred more frequently among women and there was an increasing of alterations according the age. Flattening and osteophytosis were the most common degerative changes followed by flattening and erosions. There is also a need for diagnostic studies to be conducted that would simultaneously evaluate all available techniques used to image the TMJ; in particular, to compare CBCT with other techniques that have been used for a longer period of time. Such studies would help to clarify the indications, contraindications, advantages and disadvantages of the available methods.

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