



Identification of Condylar Pathologies Using Cone-Beam Computed Tomography- A Retrospective Study

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Citation this Article: Shivani Singh, Vahanwala Sonal, Sakshi Soni, Sansare Kaustubh P, “Identification of Condylar Pathologies Using Cone-Beam Computed Tomography- A Retrospective Study”, IJMSIR - December - 2024, Vol – 9, Issue - 6, P. No. 01 – 07.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

The temporomandibular joint (TMJ) is responsible for majority of functions carried out by the dental arches. Mandibular condyle, a primary centre for growth in mandible, is covered by a cartilage which undergoes constant remodelling throughout life. Alterations in condylar morphology are a multi-factorial outcome which is dependent of age, occlusion, habits and lifestyle. This study was conducted to assess osseous changes in the bilateral condylar region and evaluate correlation with age and gender, based on CBCT images of TMJ. Corrected images of CBCT scans of right and left condyle of 140 individuals were evaluated on sagittal and coronal sections for the presence of osseous changes including flattening, osteophyte formation, erosion, sclerosis and Ely’s cyst. 10.21% of the sample depicted osseous changes in the one or both TMJs. Flattening was the most prevalent osseous finding followed by osteophyte formation, erosion, sclerosis and Ely’s cyst respectively. From our study we concluded that in the

middle age group, flattening is the most prevalent type of degenerative bone change and Ely’s cyst is the least prevalent. A definite correlation of these condylar changes with age and gender exists. Essentially, the radiologists should identify and inform such osseous changes in TMJ for appropriate early intervention.

Keywords: Mandibular Condyle, Flattening, Erosion, Sclerosis, Osteophyte, Ely’s Cyst.

Introduction

The temporomandibular or the ginglymo-arthroïdal joint (TMJ) is a synovial joint responsible for facilitating the jaw’s range of motion providing multifunctionality to the dental arches. The condyle is a primary centre for growth in mandible, contains a special cartilage (secondary cartilage), which in response to continuous stimuli undergoes constant remodelling process from childhood through adulthood. TMJ changes are quite frequent in adults, but not necessarily degenerative. Disturbed remodelling of bony articulating structures occurs due to overload in masticatory force or when the mechanical

load out-weighs the adaptive capacity of the masticatory apparatus.

Pathologies in TMJ can be viewed using panoramic and transcranial radiographs, conventional computed tomography (CT), corrected tomography of the TMJ, cone beam computed tomography (CBCT), MRI and arthrography. TMJ assessment on panoramic radiograph, lateral radiograph of skull, axial tomography does not prove to be beneficial due to anatomic overlaps- which makes visualization and interpretation difficult.^[1-4] CT is of great diagnostic value, in both clinics and research, for visualizing the mandible. However, its high-cost and high dose of radiation spells about its limitation in clinical practice. CBCT provides a three-dimensional image of the maxillofacial mineralized tissue with minimal distortion. CBCT has been shown to be efficient in the diagnosis of several bone changes that affect the TMJ. According to Tsiklakis et al and Koyama et al, CBCT is recommended for TMJ imaging, instead of CT because of lower radiation exposure and superior efficacy for visualizing bone changes of the TMJ, analysing lateral slices in isolation and combining coronal and lateral slices.^[5-7]

The aim of this study was to assess osseous changes in the bilateral condylar region and further evaluate correlation with age and gender, based on CBCT images of TMJ for better understanding.

Materials and Methods

After Institutional ethical committee clearance, 140 bilateral cone beam computed tomography scans with good visibility were retrieved from the archives of the Department of Oral Medicine and Radiology. Corrected images (Figure 1) of right and left condyle with coronal axis along long axis of the condyle were evaluated on sagittal section by scrolling from medial to lateral aspect

and the coronal plane was scrolled from anterior to posterior aspect.

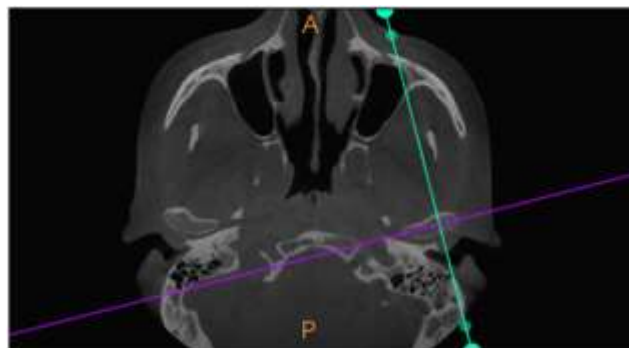


Figure 1: Corrected CBCT image of left condylar region.

The most common age-related condylar findings were studied from existing literature. Each scan was evaluated closely for:

1. Flattening: loss of an even convexity or concavity of the joint out lines. **Figure 2**
2. Osteophyte: local outgrowth of bone arising from a mineralized joint surface. **Figure 3**
3. Erosion: local area of rarefaction in the cortical plate of a joint surface. **Figure 4**
4. Sclerosis: thickening of the cortical bone on a joint surface. **Figure 5**
5. Ely's cyst (sub cortical cyst): small, round, radiolucent areas with irregular margins surrounded by areas of variable increased density evident just below the cortical plate or deep in trabecular bone.

Figure 6

A normal condyle was given a score of 0, and an abnormal condyle was given a score of 1.

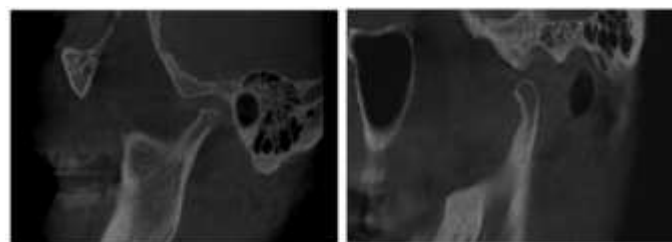


Figure 2: Loss of round contour along superior surface of right and left condylar head S/O: Flattening

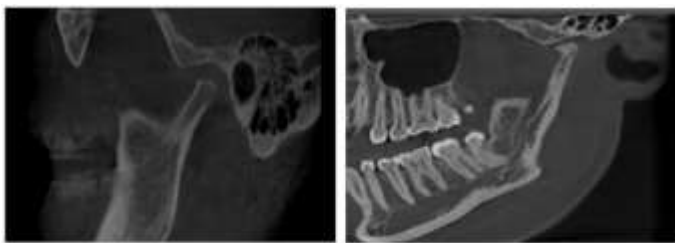


Figure 3: Prominent radiopacity seen along anterior surface of right and left condylar head S/O: Osteophyte

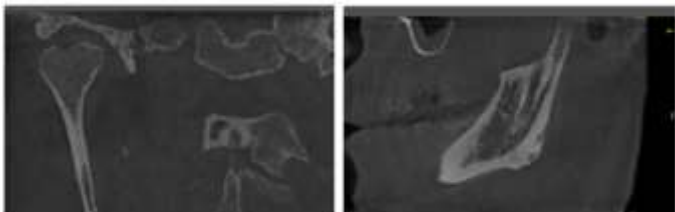


Figure 4: CBCT scan of Right & Left TMJ showing irregularity along superior surface of condylar head and loss of cortication in the central position.

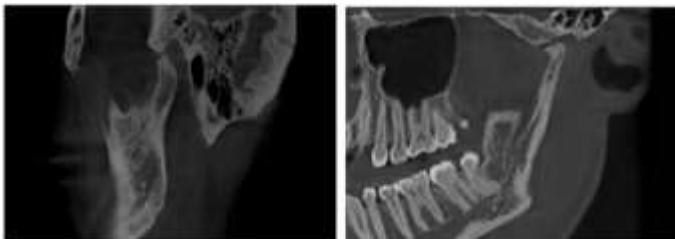


Figure 5: Sagittal Section of CBCT scan of right and left TMJ showing increased area of radiopacity in the subchondral region S/O Sclerosis.

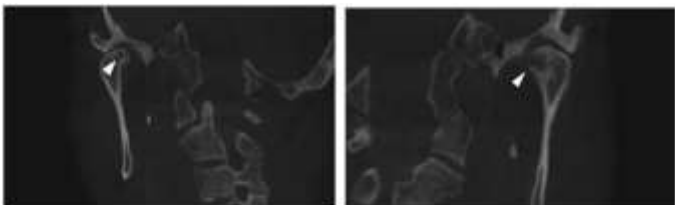


Figure 6: Coronal sections of right and left condyle showing well-defined round to oval radiolucency below the articulating surface of condylar head on the mesial aspect S/O: Ely's

Results

A prevalence of 10.21% of osseous changes in one or both TMJ was noted in the present study. 53.5% of the population showed the presence of flattening of either or both condyles with a maximum in the age range of 40-49 years with no significant correlation to age ($p=0.128$) and gender ($p=0.17$). 5 subjects showed evidence of erosion along superior surface of either or both condyles with no statistically insignificant difference within age and gender group. ($p=0.481$ for age comparison and $p=0.56$ for gender association). In our study 5% of the subjects

have evidence of unilateral or bilateral sclerosis. The gender predilection and age predilection for the presence of sclerosis was statistically insignificant ($p=0.281$ for age comparison and 0.898 for gender association). Osteophyte formation was the second most common finding in our study with 2.14% of the subjects showing its presence on either of the condyles and no statistically significant difference noted within age and gender groups. 5.7% of our study population showed presence of Ely's cyst unilaterally or bilaterally with maximum involving the right condyle. There was no significant correlation of this occurrence with age (0.481) or gender ($p=0.302$).

Table 1: Comparison of osseous changes among different age groups

Side	Category	20-29	30-39	40-49	50-59	Total	p value
Right	Flattening	11	13	20	14	58	0.136
	Erosion	1	1	1	2	5	0.854
	Sclerosis	1	0	1	1	3	0.766
	Osteophyte	1	0	1	1	3	0.541
	Ely's Cyst	2	1	3	3	9	0.603
Left	Flattening	12	13	18	13	54	0.252
	Erosion	0	0	1	1	2	0.541
	Sclerosis	0	0	3	1	4	0.101
	Osteophyte	2	1	3	3	9	0.766
	Ely's Cyst	0	0	2	1	3	0.280

Table 2: Comparison of osseous changes based on gender

Side	Category	Male	Female	p value
Right	Flattening	38	20	0.027*
	Erosion	2	3	0.660
	Sclerosis	2	1	1.000
	Osteophyte	2	0	0.500
	Ely's Cyst	3	6	0.301
Left	Flattening	30	24	0.863
	Erosion	1	1	1.000
	Sclerosis	2	2	1.000
	Osteophyte	2	1	1.000
	Ely's Cyst	1	2	0.592

Discussion

The mandibular condylar cartilage (MCC) of the TMJ is fibrocartilaginous in nature which contains both type I and type II collagen. The major role of the MCC is to support and distribute functional loads, allowing a frictionless movement and avoiding the breakdown of the cartilage. The load-bearing function of the cartilage is mediated by the extracellular matrix and the ability to withstand compressive loads is the direct function of the proteoglycans present in this cartilage. The age-related osseous changes are hypothesised to occur suspecting age-related physiologic changes in the local components

of the joint. Various studies have evaluated multiple aspects of the joint anatomy, physiology and biochemistry to understand the process of morphologic and functional alteration of the joints.

Animal studies by Chen et al (2020) observed a significant decrease in proteoglycans (safranin O staining) in the cartilage as the animal ages. Additionally, increased breakdown of the cartilage and increased OARSI histopathological score as the age increases was evident.^[8] The breakdown of the cartilage is primarily due to differential synthesis and breakdown of the extracellular matrix. Furthermore, with aging, there is a decrease in the number of chondrocytes/cells and their inability to maintain the synthetic activity leads to decreased proteoglycan secretion which may lead to cartilage breakdown. Additionally, it has also been suggested that with aging, chondrocytes undergo phenotypic changes, which may alter their response to mechanical stimuli thus promoting altered remodelling of the extracellular matrix.^[9] The critical change in the TMJ, associated with advancing age, is the replacement of cartilage with bone. The formation of calcified cartilage is due to a shift in the cellular composition, and such alterations favour the onset of degenerative disorders of the TMJ.^[10] Knowledge about radiographic identification of these bone changes and their pathogenesis is fundamental for diagnosing the dysfunctions associated with the disease and for adequate treatment planning.

The prevalence of osseous changes as noted in the present study was found to be notably lower in compared to findings from previous studies. This discrepancy can be attributed to the inclusion of a middle-aged sample population, specially individuals who did not specifically seek treatment for TMD.^[11-13] Changes in occlusion, aging changes and joint diseases are some contributing factors for alteration in condylar morphology. Though

there was no significant association of increasing age with occurrence of TMJ findings, subjects within the age range of 40-59 showed maximum osseous changes in either or both of the condyles. Cruzoe´- Rebello et al and Isberg et al ^[14] did not find any association between increased age and with presence of bone changes which is in accordance with the present study. Although the subjects in the study did not report any issues with their masticatory apparatus, their scans revealed osteolytic changes. This raises questions about whether these changes persist from a young age but only become evident later in life, particularly when the individual experiences TMJ problems. Such morphologic alterations could be further complicated by arthritis, systemic conditions, or long-standing parafunctional habits. 31.4% of the population showed osseous changes in right and left TMJ suggestive of bilateral joint involvement. Since the TMJ functions as a bilateral joint operating as a single unit, coordinated jaw movements by both joints means that changes in one side of the stomatognathic setup can affect the other. This interdependence explains the bilateral occurrence of joint changes.

The osseous changes in the TMJ observed in the present study were more prevalent in women than in men, consistent with findings from previous literature. ^[5,12] Research shows that TMD predominantly affects women, which is attributed to a combination of anatomical, biological and hormonal factors. Authors have suggested, the higher incidence of degenerative changes in females may be due to hormonal influences, particularly estrogen and prolactin, which can exacerbate cartilage and bone degradation and stimulate various immunological responses in the TMJ. Moreover, decreased production of estrogen in post-menopausal women results in low level of bone mineral density which is related to increased

TMJ radiographic changes as reported by Jagur et al, Santos et al.^[16,17]

Flattening was seen as the most prevalent osseous finding followed by osteophyte formation, erosion, sclerosis and Ely's cyst respectively. The correlation with age was not statistically significant but maximum subjects between 40-49 years had presence of flattening-bilaterally. The occurrence of flattening was in line with literature ^[11,13,19] which suggested flattening to be most prevalent in the respective samples. Excess occurrence of flattening can be attributed to the bone changes representing an adaptive alteration, the first change of a progressive disease or degenerative change secondary – culminating to internal derangement.

Osteophyte was the second most common finding in our study, similar to previous studies Kurtuldu et al^[13] and Krisjane et al.^[19] Dumbaya et al found significantly higher osteophyte prevalence in the sample itself and in comparison, to other studies.^[12]

The prevalence of erosion in study population was in consensus with results of studies by Dos Anjos Pontual M.L et al^[11], Krisjane et al ^[19], whereas Kurtuldu et al^[13] showed higher percentage in comparison to present study in spite of a similar age range of the sample evaluated. Sclerosis was seen as the fourth most common finding along condylar surface, similar to results presented by Krisjane et al^[19], Dos Anjos Pontual M.L et al^[11] and Kurtuldu et al^[13]. Since Dumbaya et al considered a sample population of only 65 years and older the occurrence of sclerosis in the sample was higher (24.4%).^[12]

Ely's cyst was the least prevalent TMJ change in our study sample as also noted in studies by Krisjane et al^[19], Dos Anjos Pontual M.L et al.^[11] The study by Dumbaya et al^[12], as referenced, highlights a significant occurrence of Ely's cysts (subchondral cysts) within their sample

population. This high prevalence was observed among individuals aged 65 years and older, indicating that with advancing age individuals are more likely to develop these cysts, potentially due to the cumulative effects of joint degeneration and other contributing factors over time. These lesions are not true cysts, but areas of degeneration that contain fibrous tissue, granulation tissue and osteoid.^[20] The presence of subchondral cyst has been suggested to be associated with four distinct disorders: osteoarthritis (OA), rheumatoid arthritis (RA), calcium pyrophosphate dihydrate deposition disease (CPPD) and osteonecrosis (ON),^[21] which should be evaluated and considered in the differential diagnosis.

The osteochondral junction is a transition between soft and hard tissues and is critical in absorbing the stresses during abnormal loading. A school of thought suggests that the radiographic findings change from one to the other or tend to exist in combination with other findings as the remodelling of the bone continues throughout life. The transition from phase of apposition to resorption leads to different characteristic appearances and reflects the joint's response to ongoing stresses and attempts to adapt to maintain functionality.

In the contest of transformation from osteoclastic to osteoblastic change, erosion is the initial stage. This remodelling indicates that TMJ is unstable and changes in osseous surface will occur whereas presence of osteophyte- which is seen at an advanced stage (where body tries to stabilize and widen the surface) is an attempt to improve overloading from occlusal areas, signifying new formed cartilage. Similarly, as a part of progression of degenerative process, sclerosis is considered to be seen later on, indicating it as an age change progressing as a permanent feature. Flattening and osteophyte formation are supposedly, mechanisms to reinforce the articulating surface. On similar thoughts,

sclerosis could be an attempt to promote subchondral reinforcement.

Understanding these processes is crucial for diagnosing and managing degenerative joint diseases effectively.

Conclusion

While considering the concept of age changes, wear and tear of TMJ was taken into consideration including changes along the condylar head region. CBCT aids in ascertaining various parameters of the TMJ anatomy and pathology. From our study we concluded that in the middle age group, flattening is the most prevalent type of degenerative bone change and Ely's cyst is least prevalent. A definite correlation of these condylar changes with age and gender exists. Essentially, the radiologists should identify such osseous changes in TMJ so that patients can be informed about the outcomes and appropriate early intervention can be done. A sample size of 140 subjects was considered in this study which limits the definitive outcome, we further suggest a larger and varied sample size to steer the research in regards to correlation between osseous changes and TMJ disorders. Coming to conclusions regarding prevalence of osseous changes in subjects, without the knowledge of patient history is one of the limitations of our study. Due the retrospective nature of the study, detailed history of TMJ symptoms of the subject (if any) was not present.

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