ORIGINAL RESEARCH

Retrospective Evaluation of Incidental Findings of Temporomandibular Joint Region in CBCT Scans

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Abstract

Aim: The present study was undertaken to investigate the occurrence of incidental findings (IFs) in the temporomandibular joint region in cone-beam computed tomography (CBCT) scans.

Materials and methods: A total of 1,850 randomly selected scans were examined for IFs in the temporomandibular joint (TMJ) area. IFs of flattening of condyle, condylar hyperplasia, condylar hypoplasia, osteophyte, osteoarthritis, bifid condyle, subchondral pseudocyst, subchondral sclerosis, and soft tissue calcification were evaluated. Data analysis was done using SPSS version 21.0.

Results: A prevalence of 59.89% of IFs was noted in the present study. Flattening of the condyle was the most reported IF found in 369 (35.6%). Soft tissue calcifications were found in 294 (28.3%) and cysts in 143 (13.8%). When gender-wise distribution of TMJ IFs was evaluated, highly significant differences were noted between the gender for flattening of condyle, hyperplasia, and osteophytes at $p < 0.001$.

Conclusion: Dentists must critically evaluate CBCT images for evidence of IFs, so as to ensure comprehensive treatment package and early diagnosis of any disorders.

Clinical significance: CBCT in the recent times is widely used in dentistry for diagnostic purposes. It not only reveals a valuable diagnostic information of the intended site but also the region surrounding it. Findings obtained in the region beyond the intended site are described as IFs, which becomes important in determining an appropriate therapeutic plan. The study was conducted to evaluate the occurrence of IFs in the temporomandibular joint region.

Keywords: Cone-beam computed tomography, Imaging, Incidental finding, Temporomandibular region.

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Introduction

Cone-beam computed tomography (CBCT) is increasingly gaining utilization as a three-dimensional radiographic imaging since its introduction in 1998.[1] It is widely employed for orthodontic, implantology, impacted tooth visualization, presurgical assessment, and dento-alveolar evaluation. Literature evidence places superior diagnostic sensitivity and specificity grading with CBCT scans when compared with other imaging techniques.[2] The 3D characteristic offers the benefit of precise localization of any finding.

The high resolution of CBCT enhances the probability of incidental findings (IFs) discovery.[3] IFs are best described as that finding not included in CBCT clinical focus and which is not detected by conventional film imaging techniques such as periapical radiographs, bitewing radiographs, or panoramic view. Field of view (FOV) large-scale view shows maxillary and mandibular regions along with adjacent structures such as paranasal sinuses, airways, and other cranial structures. The discovery of IFs paves the way for medical and legal ramifications.[4]

Temporomandibular joint (TMJ) is the most used functional synovial joint involving jaw movements as in chewing, speaking, swallowing, and breathing.[5] The uniqueness of this joint is the harmony in which muscles and bone structure work, with controlled movements of structures such as ligament, muscles, articular surface shape, and occlusion.[6,7] Temporomandibular disorders (TMDs) arise due to abnormal TMJ functioning. Literature evidence shows varying prevalence of TMDs.

Treatment plan may be altered by the presence of IFs. In majority of the times, dental intervention needs to be postponed as the patient needs to be referred to a specialist for evaluating or monitoring of the finding before commencing treatment. Atheromas, for instance, might be considered as indicators of stroke or metabolic potential for pathological conditions. IFs increase the amount of data accessible for diagnosis and might aid in the planning and proactive implementation of patient care.

CBCT provides a three-dimensional perspective of anatomical and pathological structures. It acquires numerous successive projection images in one complete scan across the region of interest using a cone-shaped ionizing radiation source and a two-dimensional area detector positioned on a rotating gantry. An X-ray source and detector are fixed to a revolving gantry that allows for imaging. Ionizing radiation from a divergent pyramidal- or cone-shaped source is directed through the center of the area

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of interest and onto an area X-ray detector on the opposite side to form an image.

CBCT scans provide more detailed information than traditional dental X-rays, allowing for precise treatment planning. Computed tomography (CT) scanning is non-invasive, painless, and accurate. The capacity of CBCT to examine both bone and soft tissue at the same time is a significant advantage. Enhanced accuracy of images, rapid scan time, reduction of effective dose, and decreased frequency of image artifacts make CBCT the favored option for the examination of oro-facial region. Properly evaluated CBCT scans facilitate the identification of IFs that are unrelated to the current disease but nonetheless have clinical importance. It would also make it easier for practitioners to conduct a thorough examination of underlying disorders, leading to life-saving interventions through early detection. Hence, the present retrospective study aimed to report IFs in the TMJ region so as to facilitate the dental practitioners in making appropriate treatment planning decision.

Materials and Methods

Study Design

A retrospective study was conducted on CBCT scans to evaluate the various IFs in the temporomandibular region.

Scan Source

A total of 1,850 randomly selected CBCT scans from a private imaging center, in the time frame of January 2019 to November 2020, formed the study sample. CBCT machine was of Carestream CS 9300, and FOV ranges from 5 × 5 cm to 17 × 10 cm and a voxel size ranges from 90 to 500 μm, with specifications set at 60–90 kv (max) and current of 2–15 mA (max). The scans were of large field view, extending from orbital roof to the second cervical vertebrae. Voxel sizes varied from 0.2–0.3 mm. Exposure time also varied with a minimal of 5.3 seconds to a maximum of 28.6 seconds.

Examiners and Reliability

Two experienced radiologists examined the scans for IFs manually. The inter-reliability coefficient to measure the consistency of the data obtained was 0.88, suggesting strong agreement between the examiners.

Eligibility Criteria

Radiographic occurrence, which was not related for the CBCT scan request, was reported as IFs. Conditions like dental caries, alveolar bone loss, and missing tooth were not included. Observations directly pertaining to the main purpose of CBCT scan request, and fragmented section scan were also excluded.

Purpose for Scan

Scans of any age, gender, and dentate state category were included. Table 1 shows the various reasons of patient referral to CBCT scan.

IFs in axial, sagittal, and coronal planes for the categories of flattening of condyle, condylar hyperplasia, condylar hypoplasia, osteophyte, osteoarthritis, bifid condyle, subchondral pseudocyst, subchondral sclerosis, and soft tissue calcification were examined. An experienced oral physician reviewed all the scans in conducive environment. All the images were coded to ensure confidentiality of patients.

Data Analysis

The findings were analyzed using SPSS 21.0 version (IBM; Chicago). Shapiro–Wilk test was used for the normal distribution of data. Chi-square test was applied to test significant difference of IFs among age-group, gender, and TMJ side. Pearson's correlation was applied to find any significant correlation between IFs and gender and age-groups. *p*-value lesser than 0.05 was considered to be statistically significant.

Results

Among the scans evaluated, 685 (61.82%) were of males and 423 (38.18%) females. Scans included all age-group population, with the highest IFs noted in 31- to 40-years age-group (39.53%) followed by 21–30 years (23.64%). Most of the scans were obtained for orthodontic assessment (58.36) followed by implant evaluation (20.38) and complicated tooth extraction (15.43) (Table 1). IFs were noted in 1,039 scans, accounting to a prevalence of 51.95%. Overall, flattening of the condyle was the most reported IF found in 369 (35.6%) (Fig. 1). Soft tissue calcifications were found in 294 (28.3%) and cysts in 143(13.8%). Figure 2 shows hypoplastic condyle on both the sides, Figure 3 shows the scan of bifid condyle with osteophyte, and Figure 4 shows the scan of cyst in condyle.

When gender-wise distribution of TMJ IFs was evaluated, highly significant differences were noted between the gender for flattening of condyle, hyperplasia, and osteophytes at $p < 0.001$. Males presented with greater IFs than females (685 vs 423). Flattening of condyle and hyperplasis was found to be significantly higher in males than in females at $p < 0.001$. Osteophytes were found to be higher in females (3.3 vs 2.4%) than in males, significant at $p < 0.001$. No difference was noted between gender for hypoplasia, soft tissue calcifications, cyst, and sclerosis. Osteoarthrosis was found in none of the scans (Table 2).

Table 1: Purpose of scan

Purpose	*N (%)*
Orthodontic evaluation	607 (58.36)
Implant pre-assessment	212 (20.38)
Difficult tooth extraction (proximity to nerve)	171 (15.43)
Dento-alveolar pathologies	76 (6.85)
Endodontic purpose	39 (3.51)
Cleft palate and cleft lip	3 (0.27)

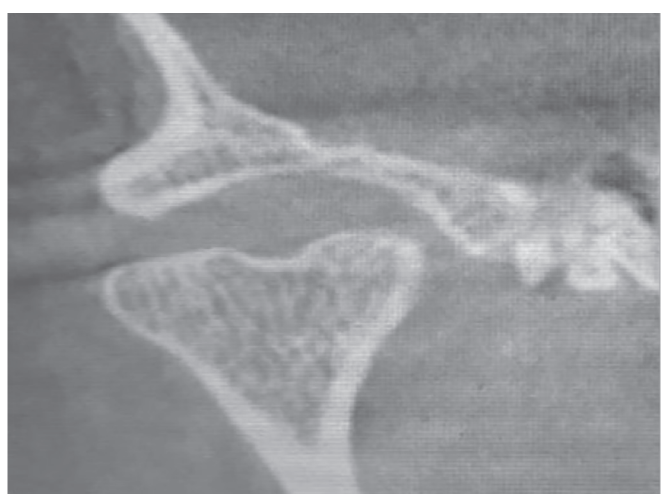

Fig. 1: Scan showing IFs of flattening of condyle

Flattening of the condyle had a definite susceptibility for the 3rd and 4th decade with 14.9 and 15.3%, respectively. Soft tissue calcifications were found maximum in the 4th decade (13.9%) (Table 3). A total of 496 scans were right-sided, while 612 were images of the left side (Table 4).

Correlations were computed for IFs among gender and age-group on dataset of 1,108 scans. The results demonstrate that gender was significantly correlated with IFs at $r = 0.553$ ($p = 0.000$) and age-groups at $r = 0.314$ ($p = 0.001$) (Table 5).

Discussion

IFs are a common prevalence in CBCT scans and reports, which have a potential to turn into serious condition, when left undetected.

Morphology of condyle is marked by a rounded bony projection with its superior border presenting a biconvex contour and oval surface on the axial plane. Variation in the morphology of the condyle can occur with age, sex, occlusal load, face type, any malocclusion, and the onset of osteoarthritis. TMJ developmental anomalies affect the condylar size and shape, which can be detected in radiographic examination. Furthermore, joint degeneration in elderly population can also present morphological changes in TMJ.[8]

Scans were primarily indicated for orthodontic reasons followed by pre-implant placement assessment in the present study. The study of Zain-Alabdeen et al.[9] also reported scans for implant

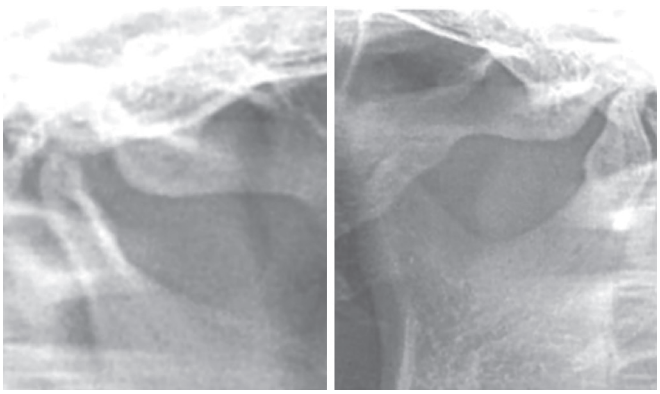

Fig. 2: Scan showing IF of hypoplastic condyle

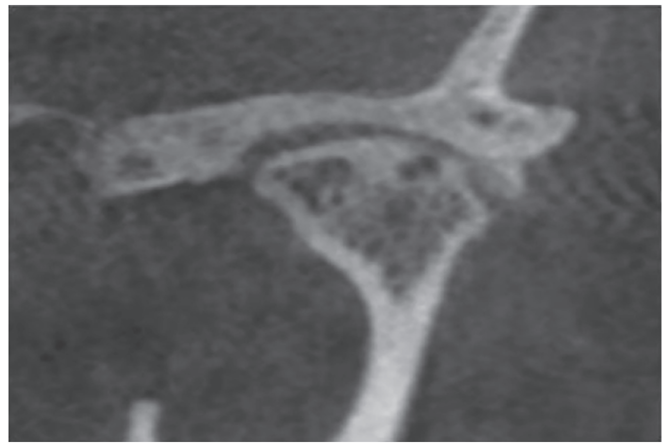

Fig. 4: Scan showing IF of cyst in condyle

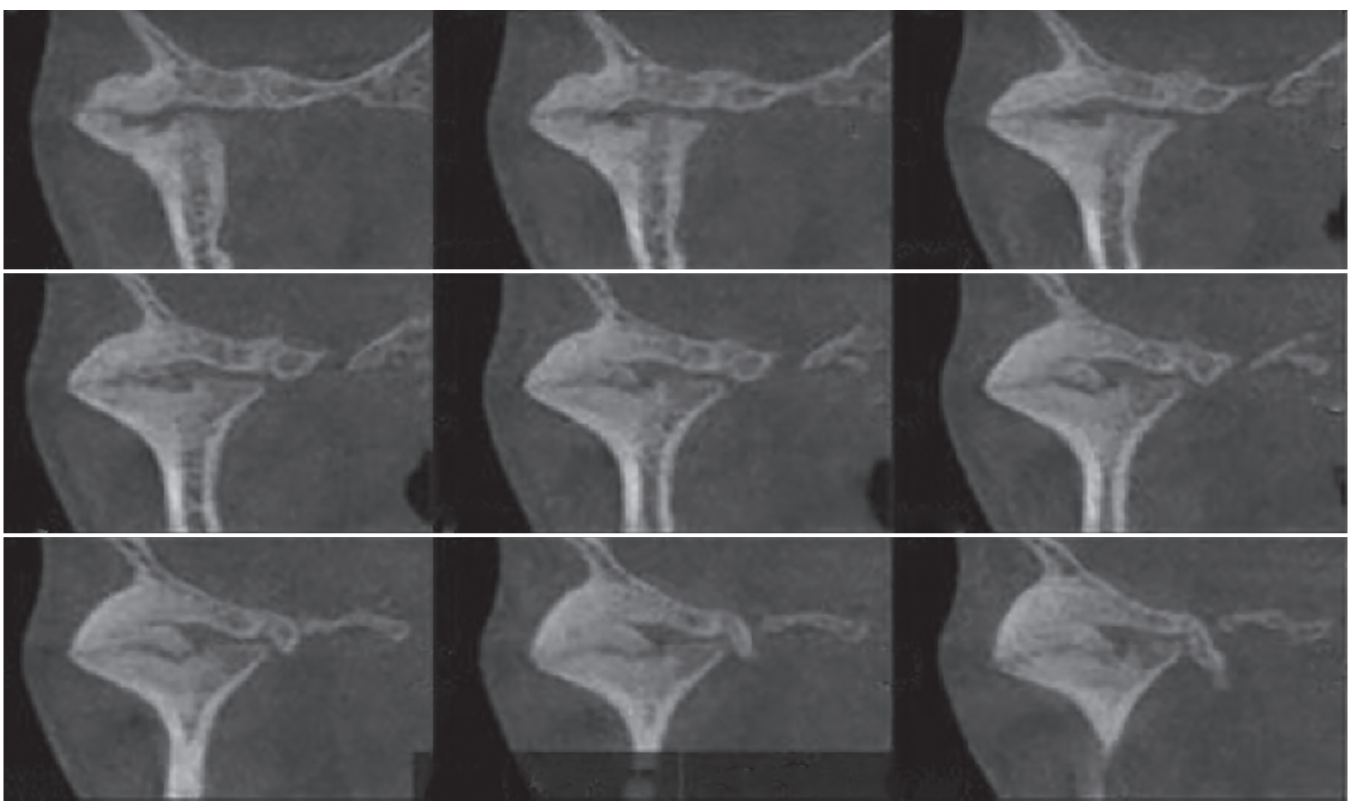

Fig. 3: Scan showing IF of bifid condyle with osteophyte

Table 2: Gender-wise distribution of incidental findings

Incidental findings	*Males*	*Females*	*Total*	*Chi-square*	*p value*
Flattening of condyle	210 (20.2)	159 (15.4)	369 (35.6)	17.54	<0.001**
Hyperplasia	53 (5.1)	6 (0.6)	59 (5.7)	16.951	<0.001**
Hypoplasia	29 (2.8)	23 (2.2)	52 (5.0)	2.050	0.101 (NS)
Soft tissue calcifications	191 (18.4)	103 (9.9)	294 (28.3)	0.003	0.522 (NS)
Osteophytes	25 (2.4)	34 (3.3)	59 (5.7)	14.076	<0.001**
Osteoarthrosis	0 (0)	0 (0)	0 (0)	—	—
Bifid condyle	26 (2.5)	24 (2.3)	50 (4.8)	3.902	0.036*
Cyst	97 (9.3)	46 (4.4)	143 (13.8)	0.585	0.253 (NS)
Sclerosis	54 (5.2)	28 (2.7)	82 (1.9)	0.029	0.485 (NS)
Total	685 (61.82)	423 (38.18)	1,108 (100)		

**Highly significant; *Significant; NS, nothing significant

Table 3: Age-group-wise distribution of incidental findings

Incidental findings	*0–10*	*11–20*	*21–30*	*31–40*	*41–50*	*51–60*	*61–70*	*Total*	*Chi-square*	*p value*
Flattening of condyle	0 (0)	3 (0.3)	155 (14.9)	159 (15.3)	0 (0)	1 (0.1)	51 (5.0)	369 (35.6)	678.212	<0.001**
Hyperplasia	0 (0)	33 (3.2)	1 (0.1)	25 (2.4)	0 (0)	0 (0)	0 (0)	59 (5.7)	30.914	<0.001**
Hypoplasia	0 (0)	5 (0.5)	0 (0)	27 (2.6)	0 (0)	20 (1.9)	0 (0)	52 (5.0)	157.843	<0.001**
Soft tissue calcifications	0 (0)	52 (5.0)	7 (0.7)	145 (13.9)	47 (4.5)	1 (0.1)	42 (4.0)	294 (28.3)	337.523	<0.001**
Osteophytes	0 (0)	0 (0)	25 (2.4)	34 (3.3)	0 (0)	0 (0)	0 (0)	59 (5.7)	81.559	<0.001**
Osteoarthrosis	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	—	—
Bifid condyle	0 (0)	24 (2.3)	0 (0)	0 (0)	0 (0)	26 (2.5)	0 (0.0)	50 (4.8)	266.108	<0.001**
Cyst	0 (0.0)	49 (4.7)	46 (4.4)	48 (4.6)	0 (0)	0 (0)	0 (0)	143 (13.8)	66.465	<0.001**
Sclerosis	0 (0.0)	27 (2.6)	28 (2.7)	0 (0.0)	26 (2.5)	0 (0.0)	1 (0.1)	82 (7.9)	187.007	<0.001**
Total	0 (5.0)	193 (17.41)	262 (23.64)	438 (39.53)	73 (6.58)	48 (8.48)	94 (8.48)	1,108 (100)		

**Highly significant

Table 4: Location-wise distribution of incidental findings

Incidental findings	*Right*	*Left*	*Total*	*Chi-square*	*p value*
Flattening of condyle	208 (20.0)	161 (15.6)	369 (35.6)	62.929	<0.001**
Hyperplasia	23 (2.2)	36 (3.5)	59 (5.7)	0.027	0.492 (NS)
Hypoplasia	48 (4.6)	4 (0.4)	52 (5.0)	62.402	<0.001**
Soft tissue calcifications	101 (9.7)	193 (18.6)	294 (28.3)	5.444	0.012*
Osteophytes	59 (5.7)	0 (0.0)	59 (5.7)	93.823	<0.001**
Osteoarthrosis	0 (0.0)	0 (0.0)	0 (0.0)	—	—
Bifid condyle	26 (2.5)	24 (2.3)	50 (4.8)	3.152	0.053 (NS)
Cyst	3 (0.3)	140 (13.5)	143 (13.8)	99.241	<0.001**
Sclerosis	28 (2.7)	54 (5.2)	82 (7.9)	1.271	0.156 (NS)
Total	496 (44.76)	612 (55.24)	1,108 (100)		

**Highly significant; *Significant; NS, nothing significant

planning as their second indication. Scans recommended for orthodontic purpose in our study could probably be because of a higher number of younger populations. Indication for request for surgical purpose ranked as third indication of our study. The study was done on 1,350 randomly taken scans. Large sample size enhances clinician's knowledge and facilitates accuracy in diagnosis. The present study had larger sample sizes when compared to those of Price et al.,[10] Rheem et al.,[11] and Ali Altındag et al.[12]

Flattening of the condyle, hyperplasia, and osteophytes distribution showed a clear male predilection, which was statistically highly significant at $p < 0.001$ in the current study. In contrast, the study of Crusoe–Rebello[13] found no difference

Table 5: Correlation of incidental findings with gender and age-groups

Incidental findings	*Gender*	*Age-groups*
Pearson's correlation	0.553**	0.314**
Significance (two-tailed)	0.000	0.001
N	1,108	1,108

between genders for temporomandibular joint derangements, stressing inconclusive evidence of hormones. The 4th decade presented higher IFs than followed the 3rd decade. Mehdizadeh et al.[14] found similar observations with 4th and 5th decade. Arnheiter et al.[15] reported observations in 21–30 years of age. The prevalence of IFs was 59.89% in the temporomandibular joint region. The present study reported higher findings when compared to the study by Mehdizadeh et al.,[14] wherein 81 out of 384 (21.1%) showed IFs in their study. Literature reporting of IFs in CBCT scans presents wide discrepancies. While our study showed a prevalence of 59.89%, Cha et al.[16] reported 3.4% in their study. This could be attributed to variations in difference in age-groups and study population characteristics.

Flattening of the condyle was the most commonly noted IF seen in 369 (35.6%) of the scans, which was in concordance with studies of Mehdizadeh et al.[14] and Price et al.[10] The second prevalent IF in the current study was soft tissue calcification in 294 (28.3) followed by cyst in 143 (13.8%) and osteophytes in 59 (5.7%) of the scans. Osteophyte presence ranked the second highest in the study of Caglayan et al. with highest being flattening and erosion of condyle. The current study showed a wide range of IFs in temporomandibular region. Various radiographic techniques are utilized to evaluate the joint area, which poses difficulty in imaging owing to factors such as superimposition of neighboring structures and morphological variations. This variability acts as an indicator for various TMJ disorders. One such IF is soft tissue calcification, which is asymptomatic but is of common occurrence. Though calcification does not require any intervention, other conditions like erosion of articular eminence, osteophytes, hypoplasia, and hypoplasia mimic TMJ disorders. Hence, diagnosing these IFs is imperative for a dentist as it helps to alleviate sufferings if detected at an earlier stage. The current study showed males exhibiting a greater number of IFs as compared to females. This was contradictory to the study of Rheem et al.[11] who reported women with greater TMJ findings.

Literature depicts varied results for the occurrence of IFs in the temporomandibular joint. This could be attributed to higher reliability and enhanced accuracy of CBCT for assessing the TMJ region as there is no superimposition of anatomical features.

The IFs in the TMJ area exhibited a lot of diversity in this investigation. TMJ is assessed using a variety of radiographic modalities, as it is a difficult location to image due to factors such as superimposition of surrounding structures and morphological changes. This TMJ variability could be a sign of a variety of TMJ illnesses. Calcifications are one of these IFs, and they are prevalent in TMJ imaging despite being asymptomatic. Although the majority of calcifications do not require treatment, some abnormalities, including erosion of the condyle and articular eminence, osteophytes, condylar hyperplasia, and condylar hypoplasia, can mimic TMJ problems. The current study emphasizes the need of dental practitioners to be aware of IFs and natural anatomical variances.

A point worth mentioning here is that though CBCT view envisages wide imaging, dental professionals still read scans with a smaller FOV, because of accustoming, which is localized primarily to the teeth and jaws. This results in missing IFs in the adjacent areas, which may require health care attention.[17]

Conclusion

Overall, the dental professionals must be aware of these IFs noted in the scans. Identifying these findings accurately will further lessen the burden of diagnostic evaluation and facilitate better planning for care. Early diagnosis also provides for the capability of finding lifesaving data along with comprehensive assessment of undiagnosed condition.

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