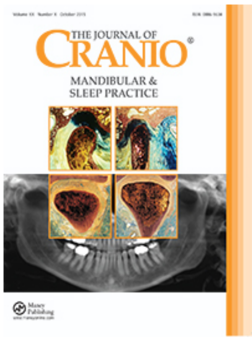

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Temporomandibular joint MR images: Incidental head and neck findings and pathologies

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ABSTRACT

Objective: To report the number and frequency of incidental findings (IFs) detected during magnetic resonance (MR) imaging screening of the temporomandibular joint (TMJ) and to define related diseases.

Methods: Bilateral TMJ MR images in the sagittal and coronal sections, from 518 patients with TMJ symptoms were evaluated retrospectively. Patients who were diagnosed with IFs were sent for consultation and clarification of the findings. Patient age, gender, IFs, locations, and diseases were classified and noted.

Results: Seventy-eight (15%) patients were diagnosed with 117 IFs. Of them, 43 were diagnosed with a single IF, and 35 were diagnosed with more than one IF. The most frequent locations were paranasal sinuses and mastoid air cells. The most frequent diseases were inflammatory and cystic lesions.

Discussion: While examining TMJ MR images, it is important to check for evidence of IFs or pathologies that may have mimicked signs and symptoms of TMJ disorders.

KEYWORDS
Incidental finding; field of view; magnetic resonance imaging; pathology; screening; surface coil; temporomandibular joint; temporomandibular disorder

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Introduction

Temporomandibular disorder (TMD) is a general term embracing several clinical problems involving the TMJ, adjacent musculature, and associated structures. TMD has been identified as a major cause of non-dental pain in the orofacial region and is considered a sub-classification of musculoskeletal disorders involving derangements of the condyle-disc complex, structural incompatibilities of the articular surfaces, and inflammatory disorders [1–3].

Several methods for imaging the TMJ have been described in literature, including magnetic resonance imaging (MRI). The merits of MRI have been well established, and it is claimed to be the method of choice for diagnosing soft tissue pathologies, including TMDs. MRI has been used to obtain information regarding the TMJ, especially the position of the articular disc. It provides a direct form of soft tissue visualization with excellent spatial and contrast resolution on sagittal and coronal sections and provides essential information about position, morphology and signal intensity characteristics of TMJ structures [4,5].

A major advantage of MRI over other radiographic imaging techniques is avoiding radiation exposure. MRI offers other advantages, such as being non-invasive and painless, while carrying minimal risk potential compared with other imaging techniques [6]. MRI is superior to many imaging modalities in the detection and characterization of soft tissue pathologies. Despite these obvious advantages, many difficulties associated with the clinical and research applications of MRI arise from the relatively long data acquisition times. Other issues, such as the high complexity of MRI and requirement for expertise, contraindications due to implants, and high costs, among others, are not considered in this review, which focuses on motion-related challenges and solutions [7].

MRI of the TMJ is generally performed with a surface coil but can also be performed with a regular head coil when no surface coil is available. However, field of view (FOV), scanning sequences and parameters, and even surface coil usage can differ among clinics due to the specifications and performance of devices. While using a surface coil, a limited area of the TMJ (around 3 × 3 inches) can

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be observed. When a regular head coil is used, larger areas can be observed but with a decreased signal-to-noise ratio (SNR). Nevertheless, even when using a surface coil with a limited FOV, several pathologies may be visualized on TMJ MRIs as incidental findings (IFs) [8,9]. Because of these limitations, some pathologies or anatomical variations may be overlooked during TMJ MRI evaluations. Another reason for misdiagnosis or even malpractice is that many clinicians do not notice anatomical structures, variations, or pathologies outside the region of primary interest [10].

According to the literature, IFs are defined as findings that appear unrelated to the clinical indication of the imaging purpose. A better understanding of IFs and improved knowledge of head and neck anatomy will allow clinicians to avoid misinterpretations. Although most IFs, such as anatomical variations, are asymptomatic and require no intervention, some may be life threatening and may warrant urgent treatment. It is also important to differentiate between IFs that are responsible for signs and symptoms of TMDs. Occult findings of other pathologies mimicking TMDs may cause misdiagnoses and could require immediate treatment.

Thus, the purpose of this study was to report the number and frequency of IFs detected during MRI examinations and to classify related diseases according to locations and types.

Materials and methods

Patient population

This study was based on TMJ MR images of 576 patients who were admitted to the authors' outpatient clinics during the past 12-year period with complaints of pain in the temporomandibular and maxillofacial area and for TMJ dysfunction. This study was approved by the Local Ethics Committee of the School of Medicine (IRB number: YDU/2017/49-440) and followed the principles of the Declaration of Helsinki, including all amendments and revisions. Furthermore, before undergoing any radiographic, intraoral, or extraoral examinations, the patients provided informed consent. Collected data were only accessible to the researchers.

All patients were examined clinically for TMJ disorders according to Diagnostic Criteria for Temporomandibular Disorders for Clinical and Research Applications [11,12] by the same clinician, and immediately after each examination, the patients underwent bilateral TMJ MRI.

Images of 58 patients, whose MRIs were not diagnostically suitable for evaluation due to motion artifacts, and images of patients who were found to have a syndromic disease or history of trauma were excluded. Various imaging modalities (orthopantomography, cone-beam computed tomography [CBCT], intraoral periapical radiography) obtained from patients were also present concerning their complaints. Data from these imaging modalities were not evaluated for IFs and were not used for the verification of IFs, in order to provide standardization in radiographic evaluation.

The final study group included 518 patients (396 females, 122 males). The mean age of the females was 28.1 years and that of males was 32.4 years; the age range was between 18 and 65 years.

Data collection

All images were acquired with one of the following 1.5-T MR scanner devices: 1.5 T Signa HDxt (GE, Milwaukee, WI, USA); Signa Horizon (GE); Gyroscan Intera (Philips Medical Systems, Bothell, WA, USA); and Magnetom SP4000 (Siemens, Erlangen, Germany). Dual 3-inch surface TMJ coils or, when unavailable, regular head coils were used. In total, 71 patients were screened with head coils to visualize the TMJ, while the remaining 447 patients were screened with surface coils.

All patients had TMJ MR images in T1-weighted, T2-weighted, fat-saturated T2-weighted sagittal sections (open mouth, closed mouth) and coronal closed mouth positions using similar repetition (TR) and echo times (TE). T1-weighted images were taken with TR = 150-300 and TE = 4.2–16, echo train length (ETL) = 10, 256 × 256 matrix, 3-mm slice thickness, number of excitations (NEX) = 2, and field of view (FOV) = 7–10 cm, whereas bilateral sagittal and coronal T2-weighted images were taken with TR = 2500–3000, TE = 93-102, and TR = 2500, TE = 102, respectively, with a 7–10 cm field of view, 192 × 256 matrix, NEX = 2, bandwidth = 15.6 kHz, and 3-mm slice thickness. Moreover, fat-saturated T2-weighted images were acquired with TR = 2000–2500, TE = 80 ms, ETL = 10, 256 × 256 matrix, 3-mm slice thickness, NEX = 2, and FOV = 7–10 cm.

Two radiologists evaluated and interpreted the images twice separately, with no knowledge of the clinical conditions of the patients. When the assessments differed, the final diagnosis was obtained by repeating the evaluation and through discussion between the radiologists. The patients who had IFs on their TMJ MR images were sent for appropriate consultations and further imaging for clarification of their conditions.

Statistical analysis

Data were collected using the Microsoft Excel program (MS Office 2010, WA, USA). Descriptive statistical

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analyses were used to calculate numbers and frequencies of IFs according to sites and diseases.

Results

In total, 78 patients, with a prevalence of 15%, were diagnosed with IFs. Of them, 56 were females and 22 were males, with a mean age of 36.2 (range, 28–65) years. In total, 43 patients were diagnosed with one IF and 35 with more than one. In total, 117 IFs were detected. All patients who were diagnosed with IFs were referred to relevant specialists to clarify the diseases where all patients should be followed.

Table 1. Locations of incidental findings and percentages.

Location	Sites	Number of cases	%
Paranasal sinuses	Ethmoid	5	6.41
	Frontal	2	2.56
	Maxillary	24	30.7
	Sphenoid	2	2.56
Salivary gland	Submandibular	2	2.56
	Parotid	2	2.56
Brain	10	12.8	
Cervical lymph nodes	1	1.28	
Middle ear	4	5.12	
Nasal cavity	2	2.56	
Mastoid air cell	14	17.9	
Masticator Space	8	10.2	
Nasopharynx	2	2.56	
Total	78	100	

The most prevalent IFs were located in the paranasal sinuses (42.1%), especially the maxillary sinus (30.7%), followed by the mastoid air cells (18%) and brain (12.7%; Table 1). The IFs were also classified according to disease. Diseases were divided into cystic (37.7%; Figure 1), tumoral (16.8%; Figure 2), or inflammatory lesions (41.9%; Figure 3, Table 2). Moreover, if a disease could not be classified into one of these categories, it was considered as an "other" lesion (3.2%; Figures 4 and 5). For cystic lesions, mucous retention cysts (30.1%), especially in the maxillary sinus, were predominant, followed by arachnoid cysts (3.4%). For tumoral lesions, cholesteatomas (3.4%) and adenoid cystic carcinomas (2.6%) were the most common. The most common pathology was inflammatory

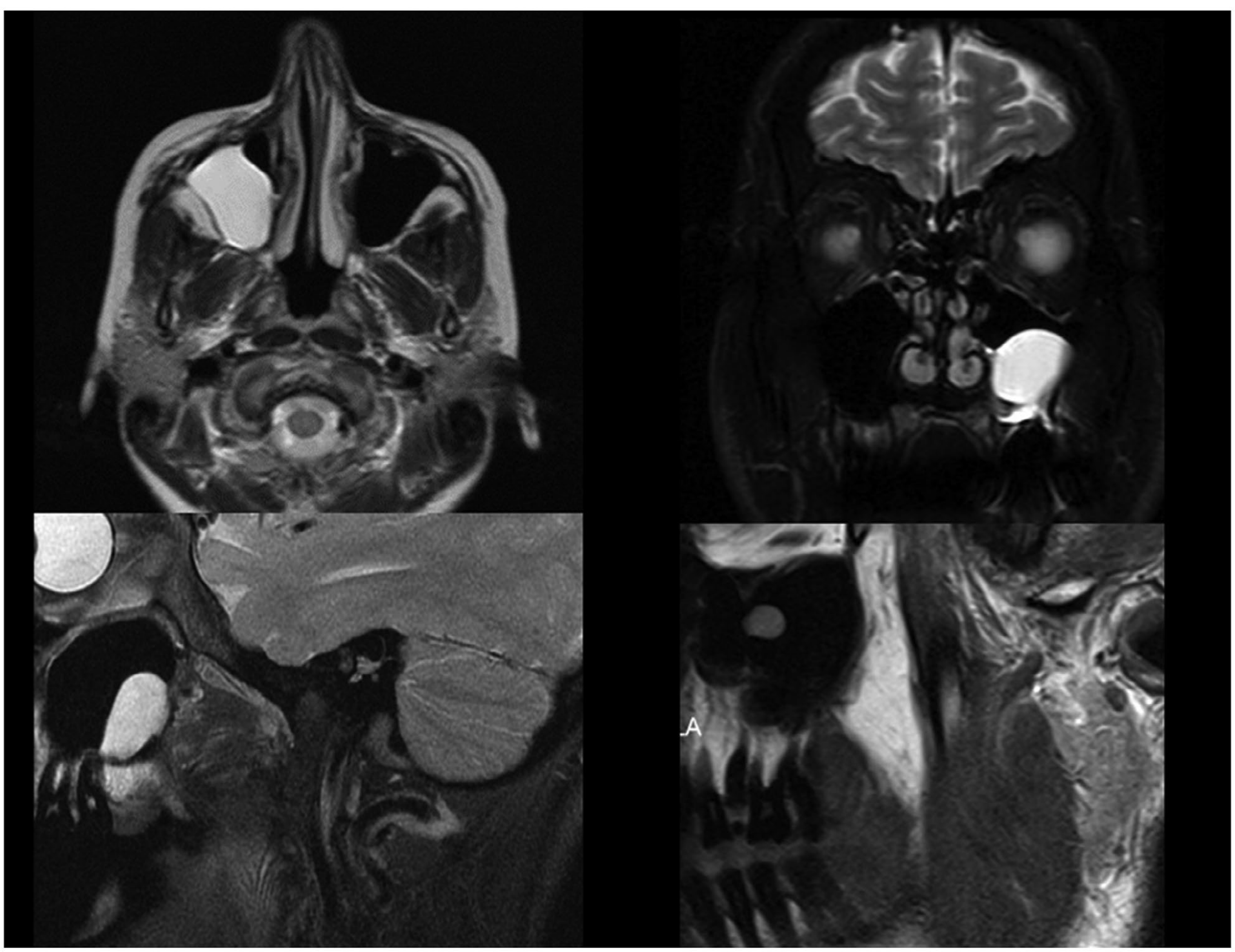

Figure 1. Axial, sagittal and coronal T1 and T2-weighted magnetic resonance (MR) images showing mucous retention cyst of a patient with bilateral temporomandibular joint (TMJ) pain.

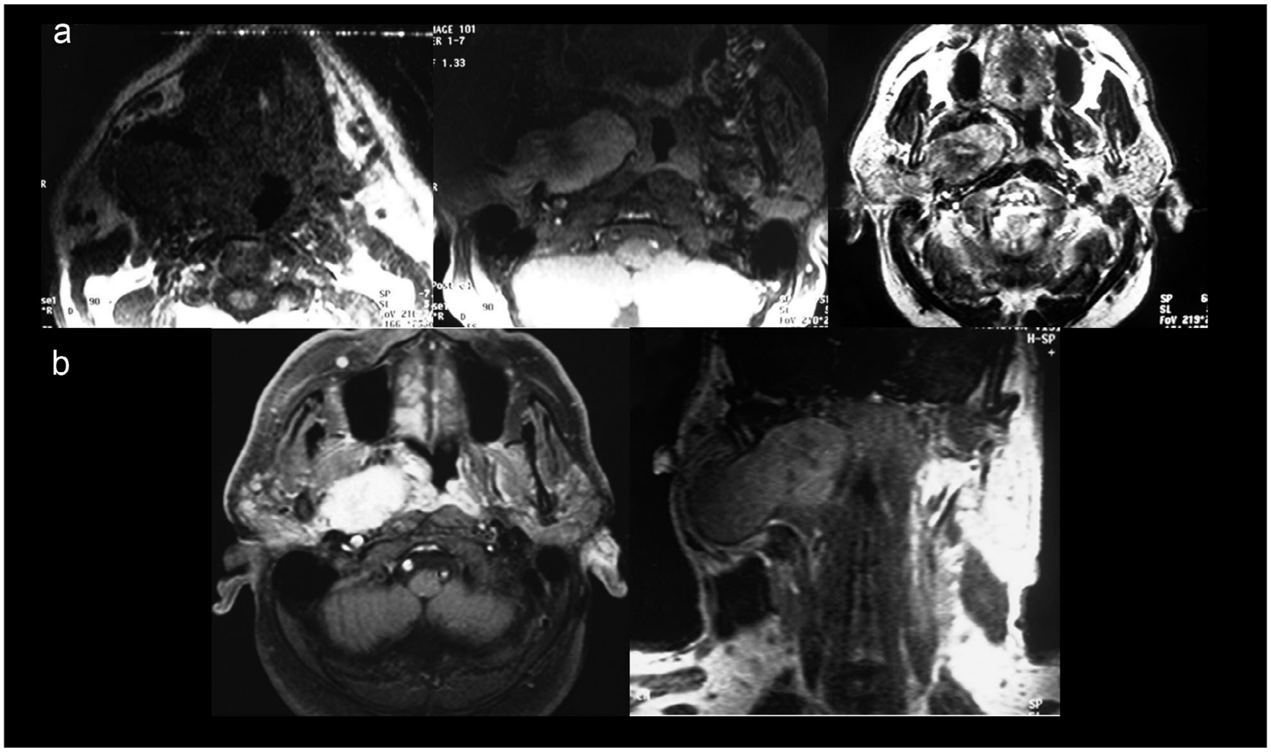

Figure 2. Hemangiopericytoma, (a) axial fast spin-echo T1 and T2-weighted magnetic resonance (MR) images showed large mass to have homogeneously increased signal with prominent signal voids, which corresponded to enlarged vessels, (b) gadolinium-enhanced fast spin-echo T1-weighted MR images show homogeneous enhancement of the mass with multiple signal flow voids representing large tumor vessels.

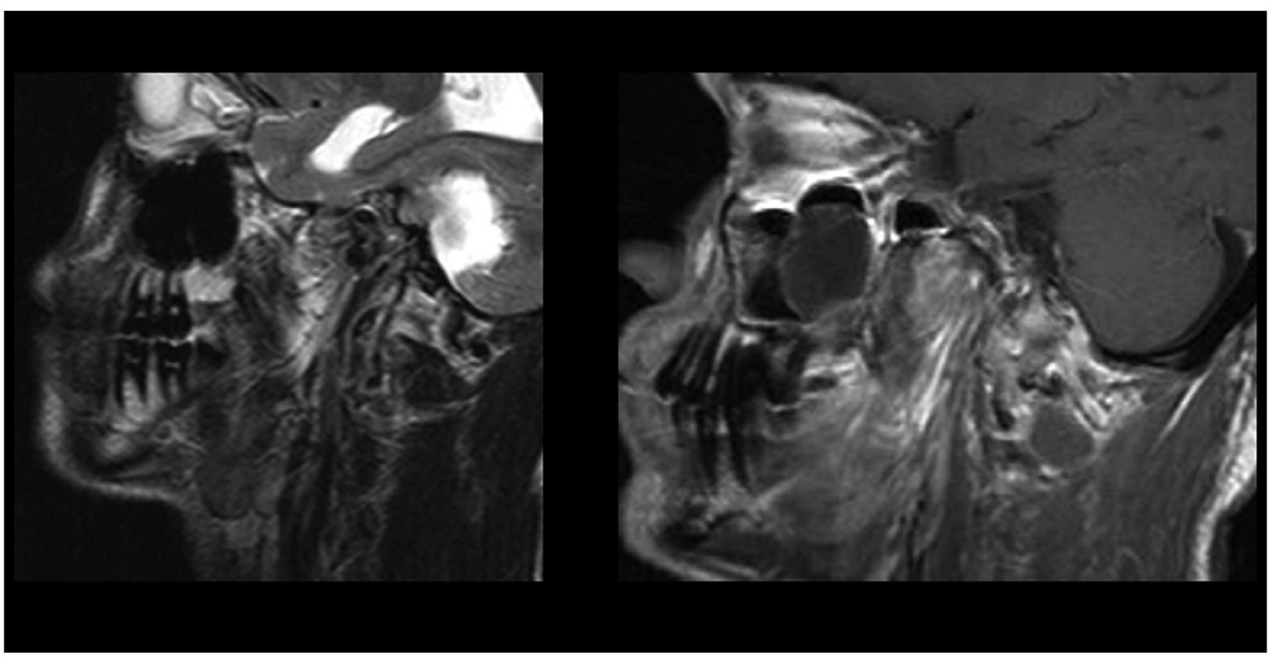

Figure 3. Sagittal magnetic resonance (MR) T1 and T2-weighted MR images showing maxillary sinusitis.

disease, including maxillary sinusitis (23.2%) and mastoiditis (12%). Two metastatic carcinomas from previously diagnosed breast (mandibular angle) and prostate cancer (condyle) were also observed.

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Table 2. Diseases diagnosed in relation to incidental findings and percentages.

	Number of cases	%
Cystic lesions		
Mucous retention cyst	35	29.91
Radicular cyst	2	1.7
Thyroglossal duct cyst	1	0.85
Epidermoid cyst	2	1.7
Arachnoid cyst	4	3.41
	44	37.6
Tumoral lesions		
Nasopharyngeal squamous cell carcinoma	2	1.7
Pleomorphic adenoma/parotid gland	2	1.7
Clival Chordoma	1	0.85
Adenoid cystic carcinoma	3	2.6
Metastatic carcinoma	2	1.7
Astrocytoma	1	0.85
Meningioma	1	0.85
Hemangiopericytoma	1	0.85
Osteoma	2	1.7
Cholesteatoma	4	3.41
Fibrosarcoma	1	0.85
	20	17.1
Inflammatory lesions		
Maxillary sinusitis	27	23.1
Sphenoid sinusitis	2	1.7
Otomastoiditis	16	13.7
Submandibular sialadenitis	1	0.85
Tonsillitis	2	1.7
Fungal infection (aspergilloma)	1	0.85
	49	41.9
Others		
Empty sella	1	0.85
Myositis ossificans	1	0.85
Maxillofacial cysticercosis	1	0.85
ICA dissection	1	0.85
	4	3.4
Total	117	100

Discussion

Temporomandibular joint (TMJ) problems are common and affect up to one-third of all adults at some stage in their lives, as well as children and adolescents. These disorders can be of muscular origin or, less commonly, they involve primarily the joint [13,14]. The use of advanced imaging techniques, including conventional radiographs, contrast arthrography, arthroscopy, computed tomography (CT), cone beam CT (CBCT), high-resolution ultrasonography (USG), and MRI is important in diagnosis and treatment planning.

It has been reported that clinical examination alone is insufficient for diagnosing degenerative joint diseases and that MRI is a necessary diagnostic adjunct for estimating the prevalence of TMD subgroups in non-patient populations [15]. Nevertheless, MRI also has disadvantages, including high cost and limited availability [16]. Moreover, the combination of being placed in an enclosed space and exposed to loud noises (made by the magnets) can cause claustrophobia during the scan. Another known disadvantage that should be taken into consideration is false-positive/negative findings on MRIs. These false findings cannot be verified without surgical confirmation [16].

Combined imaging in the sagittal and coronal planes provides good definition of the spatial relationship between the disc and the condyle, and MRI has been proposed as the gold standard for this purpose [17,18]. MRI of the TMJ can also supply information on the quantity of synovial fluid, the condition of the bone, posterior

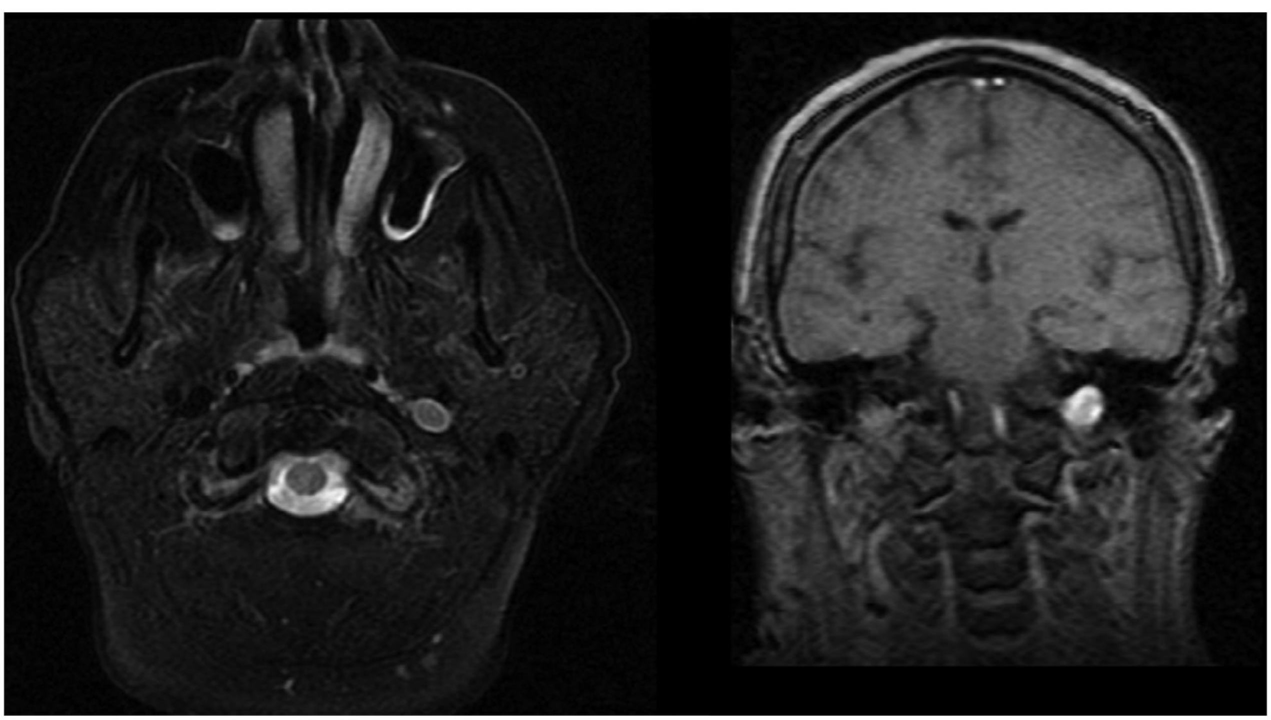

Figure 4. Axial STIR (Short TI inversion recovery) and coronal T1-weighted images showing internal carotid artery dissection (ICA).

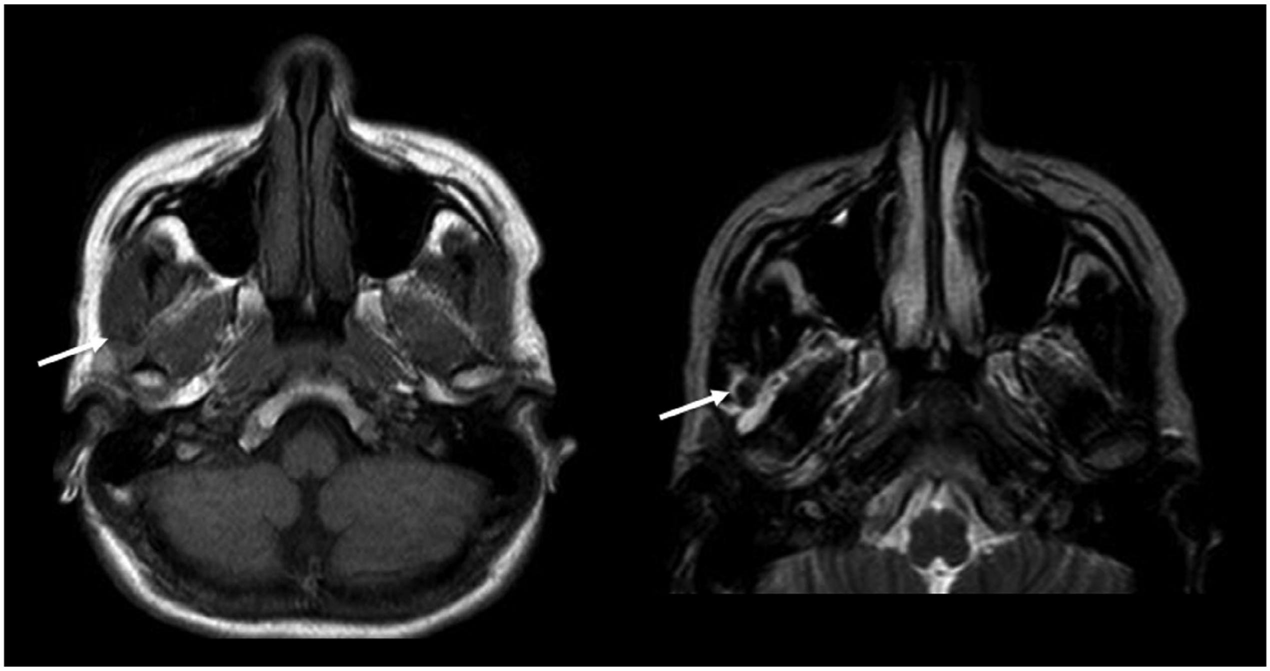

Figure 5. Axial T1 and T2-weighted images showing maxillofacial cysticercosis buried in masseter muscle.

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attachment and the retrodiscal tissues, the bone marrow, and the peri-articular tissues [17,19–25].

Over recent years, improvements in diagnostic quality and more widespread use of these devices have resulted in an increase in IFs observed by diagnostic radiologists, although literature concerning IFs during TMJ MRI examinations is scarce [26,27] because of the limited FOV with TMJ surface coils. During MRI examinations, using a TMJ surface coil is considered the best choice in the examination of TMDs because it limits the examination area to the center of the condylar head and provides high spatial resolution and a good SNR [26]. The MR signal received by the surface coil is reduced markedly with distance from the coil surface. Thus, a surface coil is unsuitable for the delineation of anatomical structures in the deep portion, and any diagnosis in the deep portion has lower reliability. When using a conventional head coil, time resolution must be sacrificed to acquire the same level of spatial resolution and SNR as when using a TMJ surface coil. This causes an increase in the opportunity for motion artifacts to occur and will reduce the throughput of patients.

In this study, 71 patients were screened with head coils, while the remaining 447 patients were screened with surface coils to visualize the TMJ. Yanagi et al. [26] reported incidentally found tumors during 2,776 TMJ MRI examinations for joint arthrosis. A 0.072% unexpected tumor rate was observed, which was lower than in other studies. They considered this outcome to be due to the use of TMJ surface coils. In this study, involving 518 patients, 71 were screened with head coils, while the remaining 447 patients were screened with surface coils with an IF rate of 15%, which was higher than that reported by Yanagi et al. [26]. This outcome supports the idea that IF rates from MRI images using TMJ surface coils are lower than with MRI images using head coils.

Another study, by Makdissi et al. [27], reported the prevalence of IFs in MR images of the TMJ. They conducted their study on 731 MRI reports, which were analyzed by a consultant and a clinical lecturer in dentomaxillofacial radiology. They divided their findings into intracranial (1.5%) and extracranial (5.7%), with a total of 7.3%. They reported that eight intracranial findings needed further imaging and specialist consultations. In the study, all patients were sent for appropriate consultations and further imaging to relevant specialists, and final diagnoses were reached thereafter.

Several studies have investigated IFs, especially with CBCT. Some of these studies are available in the literature and include specific samples, such as orthodontic patients [28–30]. Some authors investigated IFs in specific regions, such as the maxillary sinuses and nasal area. In the literature, the frequencies of septal deviation, concha bullosa, Haller cells, agger nasi, and Onodi cells were in the ranges 3.4–81.8%, 2.72–67.5%, 19.3–68%, 63.8–93.2%, and 14.4–49.5%, respectively [26–31]. It has been stated that not only mucosal abnormalities but also anatomical variations, such as nasal septum deviation, concha bullosa, Haller cells, agger nasi, and Onodi cells, should be evaluated carefully for the presence of sinusitis [32–37]. IF rates on CBCT examinations vary between 18.2 and 79.3%

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[38–41]. However, to the authors' knowledge, IFs in TMJ CBCT patients have not been investigated. Further studies using only CBCT examinations of the TMJ or combined CBCT and MRI examinations should be done with larger population samples.

As in previous studies, the most common IFs were found in paranasal sinuses. Moreover, it was also stated that, "although patients were diagnosed as having TMJ disorders and treated, other lesions may induce TMJ disorder-like symptoms" [37] in which treatment differs from that for the TMJ disorders. In this study, all patients complained of pain in the temporomandibular and maxillofacial area and were radiologically and clinically diagnosed with TMD, although some of the identified IFs were located in the salivary gland (parotid), middle ear, mastoid air cells, and masticator space. Pathologies like pleomorphic adenoma, clival chordoma, metastatic carcinoma, astrocytoma, hemangiopericytoma, cholesteatoma, fibrosarcoma, maxillary and sphenoid sinusitis, otomastoiditis, empty cells, myositis ossificans, maxillofacial cysticercosis, and internal carotid artery dissection (ICAD) might have been responsible for the signs and symptoms of the TMJ noted on MRI. Because all the patients had TMD in addition to other pathologies, IFs and occult conditions could not be distinguished.

Conclusion

In conclusion, although IFs revealed during TMJ MRI examinations are rare, it is important to examine not only the TMJ structures, but also to look at nearby anatomical features to check for evidence of IFs. Conventional MRI screening of the TMJ may lead to the detection of lesions other than TMJ disorders. Such findings may reveal the cause of complaints and may occasionally be significant and require differing modalities of diagnosis and treatment.

Disclosure statement

No potential conflict of interest was reported by the authors.

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