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RESEARCH

Incidental findings on MRI of the temporomandibular joint

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Objectives: The aim of this study was to determine the prevalence of incidental findings in MRI of the temporomandibular joint (TMJ).
Methods: MRI reports of 730 patients were assessed. The reports were analysed by one consultant and one clinical lecturer in dental and maxillofacial radiology. The prevalence of intracranial and extracranial incidental findings was recorded and categorized.
Results: There were 53 (7.3%) incidental findings, of which 11 (1.5%) were intracranial and 42 (5.7%) were extracranial (divided into paranasal sinuses, mastoid air cells, muscle hypertrophy, lymphadenopathy and salivary glands). A total number of eight intracranial findings needed further dedicated imaging and/or specialist clinical opinion. Only one tumour (a meningioma) was found and required surgical intervention.
Conclusions: Incidental findings on TMJ MRI are rare but not unheard of. The clinical relevance of incidental findings can be significant, and it is therefore important to ensure that the full data set of images is inspected, including any scout slices. A close working relationship between the areas of dental and maxillofacial radiology and neuroradiology is essential in expediting a second opinion relating to intracranial findings. All incidental findings should be communicated to referring clinicians in a timely manner, based on their urgency and clinical significance.
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Introduction

Incidental findings are commonly observed by radiologists in all imaging modalities. An increase in the number of diagnostic investigations carried out, coupled with improvements in the diagnostic quality of these modalities, has resulted in a higher frequency of detecting such findings. These pose a diagnostic dilemma to the reporting radiologist. Often they are only partially visualized, and when fully visualized, dedicated sequences are not usually available.

Multitudes of imaging modalities have been used to assess the temporomandibular joint (TMJ), with varying success rates. These included panoramic and plain film radiographs,[1–3] contrast arthrography,[4] arthroscopy,[5,6] CT[7] and cone beam CT.[8,9] With internal derangement being the most common abnormality of the TMJ, MRI remains the most valuable tool in assessing the articular surfaces, the disc, the joint space size, the range of movement on opening and the presence of joint effusion.[3] The TMJs are best imaged in sagittal oblique and coronal planes. To obtain the most representative slices, a scout image is used to determine the long axis of the condyle and the angulation and orientation of the required slices. The scout, sagittal oblique and coronal images cover areas outside

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the TMJ, such as the maxillary sinus, salivary glands, muscles and the cranial cavity.

Mirilas and Skandalakis[10] described the concept of incidentaloma, "a totally asymptomatic non-functional tumour that is clinically and biochemically silent and discovered incidentally in a totally asymptomatic patient", as being the by-product of the evolving diagnostic techniques of the past three decades. "Incidentaloma" has often been used in the literature to describe incidental findings in different parts of the body when using various imaging modalities, such as CT, MRI, ultrasound and nuclear medicine examinations. These include adrenal masses,[11,12] hepatic tumours[13,14] and pancreatic tumours.[15] In the head and neck, incidental findings were reported in the brain,[16] thyroid,[17,18] parathyroid[19] and pituitary glands.[20] However, Mirilas and Skandalakis[10] stated that the term incidentaloma should be abolished and replaced with the term "incidentally found".

The frequency of incidental findings varies according to modality and area of interest, and is specific to examinations. Incidental findings on brain MRI have shown the prevalence of neoplastic findings to be 0.7%, compared with non-neoplastic findings of 2%.[21] CT angiography of abdominal aorta and lower extremities showed 15% previously undiagnosed extravascular incidental findings.[22] The prevalence of incidental non-cardiac findings on CT coronary angiography can range from 15% to 58% of patients.[23]

The objective of this paper is to determine the prevalence of incidental findings (intracranial or extracranial) in MRI of TMJ.

Materials and methods

A retrospective analysis of all MRI examinations of the TMJ was carried out in one centre between November 2006 and March 2010. The total number of cases was 730. The project was evaluated by the National Research Ethics Committee. Internal derangement was suspected following clinical examination in cases referred to the Oral and Maxillofacial Surgery Department. Further evaluation of the articular disc was required to confirm clinical findings. All scans were performed using a GE Signa 1.5 T magnet (GE Healthcare, Milwaukee, WI,). Sagittal oblique proton density and T_2 weighted imaging sequences in both closed and open positions were obtained. Bilateral surface coils were used with an eight-channel high-resolution head coil. The matrix size was 256 × 192. The field of view (FOV) was 120 mm for dedicated TMJ views and 240 mm for all scout images. For proton density sequences, repetition time (TR) was set at 1640 ms and echo time (TE) at 24 ms. For T_2 weighted sequences, TR was set at 320 ms and TE at 15 ms. The slice thickness was 2 mm (4 mm for scout images) with no spacing; the flip angle and bandwidth were 20° and 8.93 kHz, respectively; and the number

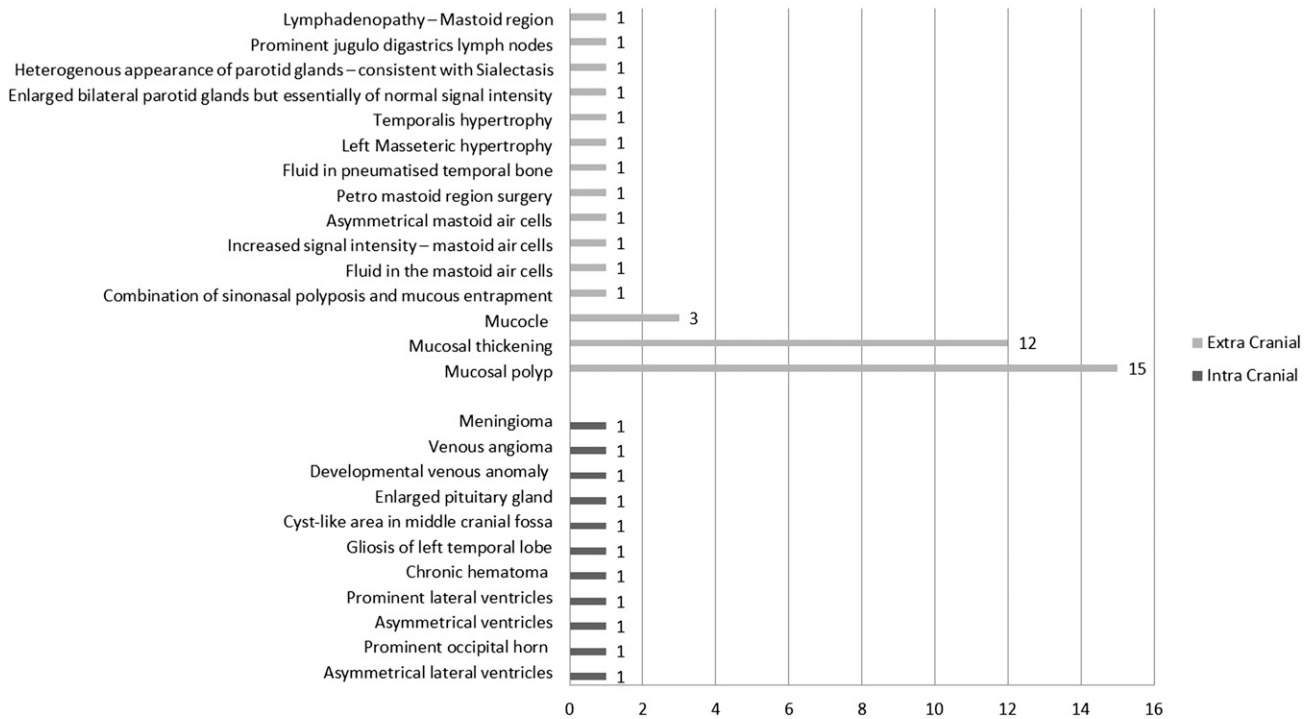

Figure 1 Bar graph representing the number of intracranial and extracranial incidental findings, showing that the most common extracranial findings is mucosal polyp ($n = 15$) and mucosal thickening ($n = 12$)

Table 1 List of intracranial and extracranial incidental findings from the 52 cases seen in the sagittal oblique/scout images of TMJ MRI

Intracranial and extracranial incidental findings in MRI TMJ				
Site		*Condition*	n	*Dedicated investigation*
Intracranial ($n = 11$)	Brain	Asymmetrical lateral ventricles	1	MRI head
		Prominent occipital horn (Figure 1)	1	MR brain
		Asymmetrical ventricles	1	Dedicated scans advised
		Prominent lateral ventricles	1	No further intervention
		Chronic haematoma (Figure 2)	1	MRI head
		Gliosis of left temporal lobe	1	MRI head
		Cyst-like area in middle cranial fossa	1	MR brain
		Enlarged pituitary gland	1	CT demonstrated normal gland and fossa
		Developmental venous anomaly (Figure 3)	1	MRI brain
		Venous angioma	1	No further intervention
		Meningioma (Figures 4 and 5)	1	MRI brain, CT, clinical and surgery
Extracranial ($n = 42$)	Maxillary sinus	Mucosal polyp (Figure 6)	15	No further intervention/investigation required
		Mucosal thickening	12	No further intervention
		Mucocele (Figure 7)	3	CT/ENT referral
	Ethmoidal air cells (Figure 8a,b)	Combination of sinonasal polyposis and mucous entrapment	1	CT and ENT referral
	Mastoid air cells	Fluid in the mastoid air cells	1	No further intervention
		Increased signal intensity—mastoid air cells	1	No further intervention
		Asymmetrical mastoid air cells	1	No further intervention
		Petro mastoid region surgery	1	No further intervention
		Fluid in pneumatized temporal bone	1	No further intervention
	Muscle	Left masseteric hypertrophy	1	No further intervention
		Temporalis hypertrophy	1	No further intervention
	Salivary gland	Enlarged bilateral parotid glands but essentially of normal signal intensity	1	No further intervention
		Heterogenous appearance of parotid glands—consistent with sialectasis	1	Ultrasound—salivary glands
	Lymph node	Prominent jugulo digastrics lymph nodes	1	No dedicated imaging (ultrasound carried out 4 years after the MRI)
		Lymphadenopathy—mastoid region	1	No further intervention
Total	53 incidental findings in 52 cases, as 1 case had 2 findings		53	

ENT, ear, nose and throat; TMJ, temporomandibular joint.

of excitations was set to 3.00. Scout images in the axial plane were acquired to demonstrate the long axis of the condylar heads to plan the most representative sagittal oblique sections (Figure 1). Data were viewed using a medical-grade monitor (Nio 3MP E-3620 MA; Barco Inc., Rancho Cordova, CA).

At least 99% of these examinations were reported by a single dental and maxillofacial radiology specialist. The remaining examinations (about six) were reported by one of the two neuroradiology specialists. A second opinion was obtained from a neuroradiologist specifically in intracranial findings. Any finding outside of the TMJ itself was considered an incidental finding.

Results

In our series of 730 MRI examinations, there were a total of 53 incidental findings in 52 cases (1 had 2 different findings). 11 were intracranial and 42 were extracranial. Nine of the intracranial incidental findings need further investigation. Four of the extracranial findings were referred to the ear, nose and throat (ENT) department and one had an ultrasound examination. The findings are listed in Table 1 and Figure 1.

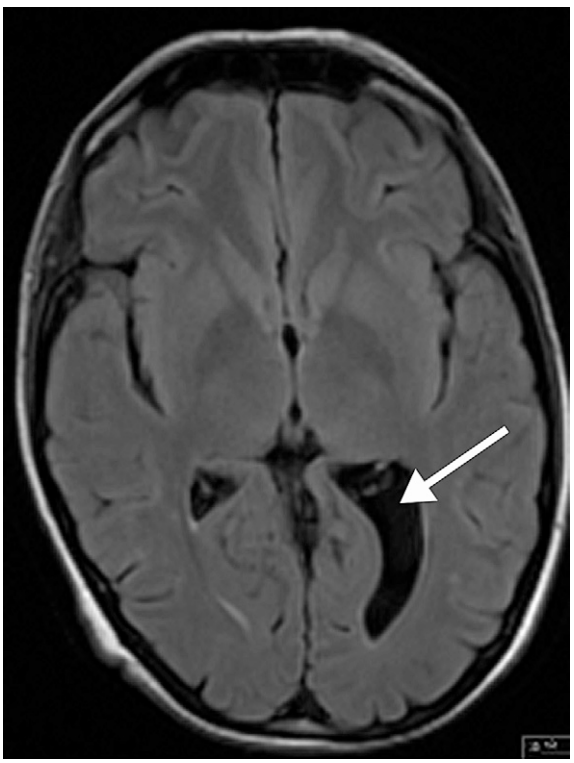

Figure 2 An axial MR image with a white arrow showing large occipital horns

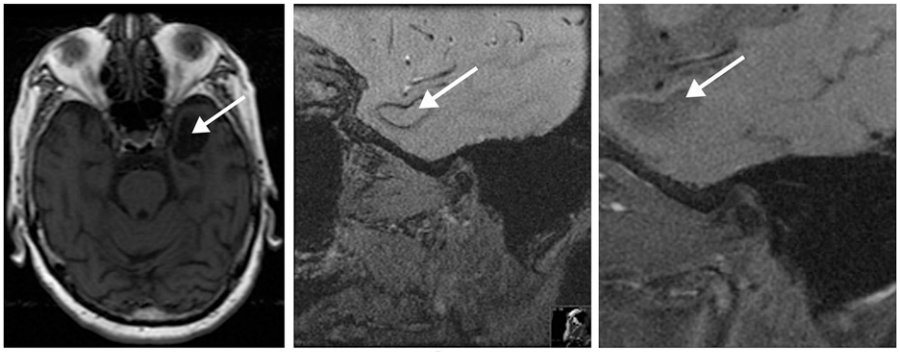

Figure 3 Hypointense lesion with loss of surrounding tissue with a thin cortex consistent with chronic haematoma demonstrated by a white arrow seen on (a) axial, (b) T_2 sagittal oblique and (c) proton density sagittal oblique

Intracranial findings

Intracranial cavity is partially imaged during a standard MRI examination of the TMJ. This is usually demonstrated in both scout images and cross-sectional sagittal oblique dedicated slices of the TMJ.

It is therefore possible to incidentally pick up intracranial findings on TMJ imaging. This was the case in 11 (1.5%) patients in this series. Variable conditions with variable clinical significance were detected, of which nine needed further imaging (eight MRI, two CT and one case needed both MRI and CT).

Enlarged occipital horns were noted in 3 cases: 1 female aged 43 years; 1 female aged 64 years; and 1 male aged 65 years (Figure 2). Dedicated brain MRI was carried out in only one case. Enlarged ventricles for the patient's age were noted in one case (a male aged 49 years). No dedicated scans were carried out.

One hypointense lesion with peripheral haemosiderin was noted in 1 case (a male aged 83 years). This was suggestive of previous traumatic contusion or chronic haematoma and required no dedicated imaging (Figure 3).

Abnormal signal intensity area was seen in the right frontal lobe on the most superior slice of the scout images of TMJ in one case (a male aged 35 years). This was further evaluated with a dedicated brain MRI study that demonstrated the presence of a developmental venous anomaly. Clinical evaluation concluded that no further action is needed (Figure 4). In one other case (a male aged 46 years), a linear signal intensity change in the cerebellar hemisphere consistent with venous angioma was noted. No further dedicated imaging was required.

Significant tissue loss was noted in the left temporal lobe in one case (a female aged 39 years). Dedicated brain MRI confirmed left temporal lobectomy. A rounded area of low attenuation was noted in the right temporal lobe (a male aged 70 years). Dedicated brain MRI and CT confirmed benign non-specific cystic lesion.

Enlarged pituitary gland was suspected in one case (a female aged 27 years). This was investigated with CT, and no mass was found.

The most significant intracranial finding was noted in a 34 year old female with abnormal intracranial lesion noted on the TMJ scout images (Figure 5). Dedicated enhanced brain scans revealed the presence of an extra-axial enhancing soft-tissue mass measuring 3 cm in diameter within the left middle cranial

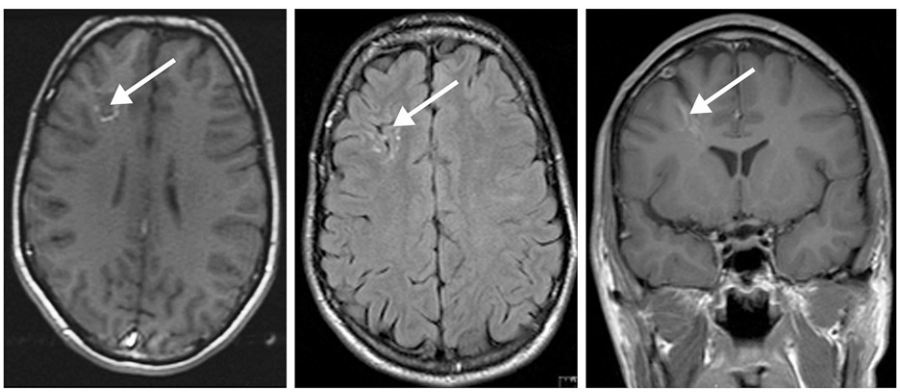

Figure 4 (a,b) Axial images and (c) coronal section through the frontal lobe showing a cluster of veins (white arrow) giving a caput medusa-like appearance of developmental venous anomaly

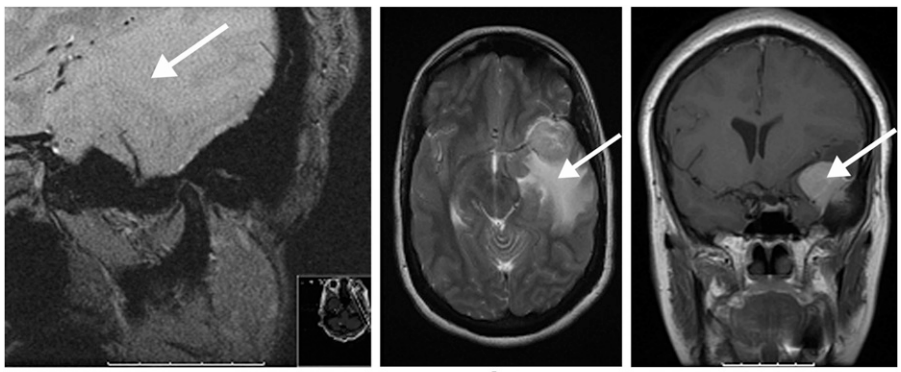

Figure 5 MR images showing meningioma (white arrow). (a) Sagittal oblique; (b) axial; (c) coronal

fossa with perilesional oedema. The lesion was intimately related to the left middle cerebral artery and its trifurcation. There was partial effacement of the ambient cistern on the left side, and the left lateral ventricle was slightly distorted. A midline shift to the right was noted. Adjacent bony hyperostosis of the greater wing of the sphenoid was very well visualized and confirmed on the subsequent CT scan (Figure 6). The appearance was consistent with middle cranial fossa meningioma (Figure 5). This was later managed by neurosurgery.

Figure 6 An axial CT image showing hyperostosis of greater wing of sphenoid demonstrated by a white arrow

Extracranial findings

Similarly, a number of extracranial structures were visualized during TMJ imaging both on axial scout images and dedicated cross-sectional sagittal oblique slices of the TMJ. These include the paranasal sinuses, mastoid air cells, masticatory muscles and salivary glands. The total number of findings was 42 (5.7%). The most commonly observed finding was maxillary sinus mucosal polyposis ($n = 15$) (Figure 7) and mucosal thickening ($n = 12$). Three cases presented with a mucocele in the maxillary sinus (Figure 8). Two cases were followed up with a CT. One demonstrated nasal septum deviation and a prominent bony spur extending into the middle meatus, causing developmental narrowing and elevation of the uncinate process and middle turbinate. One other case presented with a combination of sinonasal polyposis and mucus entrapment (Figure 9). This patient underwent further CT imaging and an ENT consultation with no intervention. Mastoid air cells asymmetrical signal intensity ($n = 5$) were noted, of which one also had mucosal thickening. Muscle hypertrophy of the masseteric/temporalis muscle ($n = 2$) was noted. There were two cases of salivary glands abnormalities, the first being enlarged parotid glands with normal signal intensity and the second being sialectasis that appeared to be under investigation. Prominent jugulodigastric lymph nodes were noted in one scan and mastoid region lymph nodes in another. No dedicated images were carried out in both cases.

Discussion

Incidental findings pose a diagnostic challenge to the reporting radiologist. Often they are only partially visualized, and when fully visualized, dedicated sequences are not usually available. Like any other imaging modalities, incidental findings can be detected during imaging of the TMJ.

Thompson et al[24] described 31 incidental findings of sinus change in a total of 405 CT head examinations. This is equivalent to the rate of 7.6%. Our study showed a slightly lower rate of 4.2%.

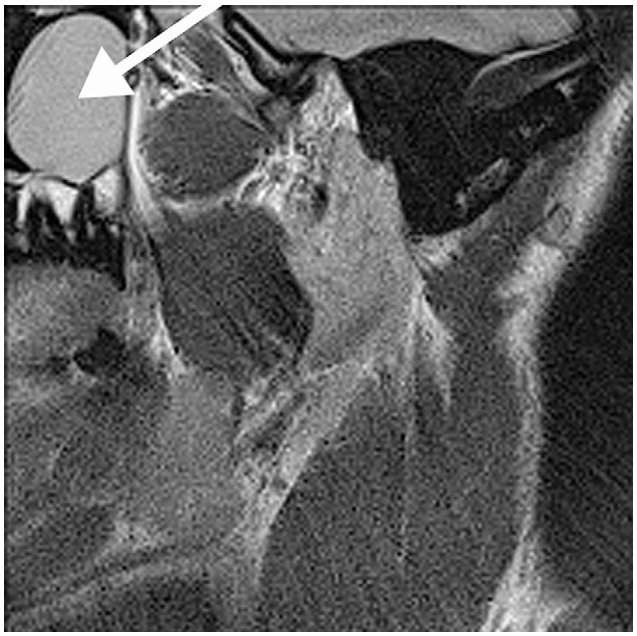

Figure 7 Mucosal polyp, demonstrated by a white arrow, incidentally seen on a temporomandibular joint MRI scan

They range from simple mucosal polyps in the paranasal sinuses requiring no treatment to an intracranial tumour requiring surgical intervention. In this study, there was one finding that was not identified at dedicated imaging (suspected pituitary mass). Although, the reporting radiologist should take care to examine the entire image FOV, some caution is required to avoid overreporting abnormalities on non-targetted images. A number of artefacts are recognized at the edge of the scan FOV, including signal intensity variation (bias field) and geometric distortion. Further, the contrast weightings used for TMJ imaging are not those routinely used for either intracranial or extracranial imaging, and interpretation of signal intensity abnormalities may be different.

A systematic review of the incidental findings on brain MRI has shown the prevalence of neoplastic incidental brain findings to be 0.7%, compared with non-neoplastic findings of 2%. The prevalence increases with age and with the use of high-resolution MRI.[21] Our series showed the rate of neoplastic findings to be 0.13% ($n = 1$) and non-neoplastic findings to be 1.36% ($n = 10$).

Although there are many papers in the literature discussing incidental findings on other parts of the body, no paper to our knowledge has ever been published on the rate of incidental findings in MRI of the TMJ. One paper was found that discussed the prevalence of tumours found incidentally on TMJ imaging. In this paper, Yanagi et al[25] reported an incidence rate of 0.072% (2 cases only) in a study of 2776 MRI examinations. The first case was an adenoid cystic carcinoma of the right parotid gland and the second case was a neoplastic lesion extending from the right infratemporal fossa to the parapharyngeal space. This was suspected to be a synovial sarcoma or a malignant mixed tumour.[25] Yanagi et al[25] explained the

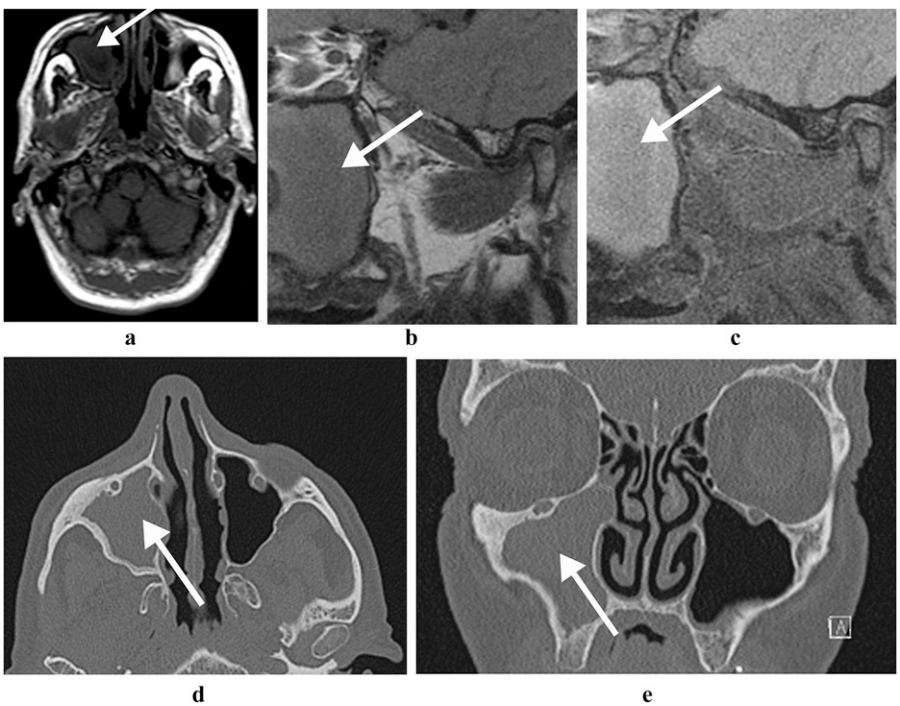

Figure 8 Mucocele (white arrow) in the right maxillary sinus seen on (a) MRI temporomandibular joint (TMJ) scout, (b) MRI TMJ proton density, (c) MRI TMJ T_2, (d) CT axial and (e) CT coronal

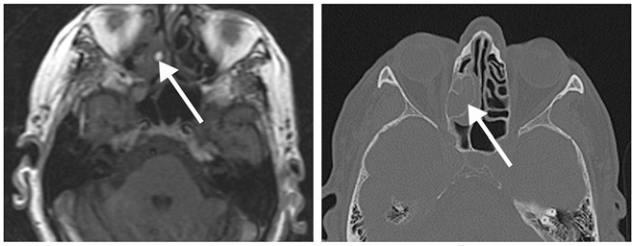

Figure 9 (a) MRI scout image showing fullness of the ethmoidal air cell and (b) CT axial section showing a combination of sinonasal polyposis and mucus entrapment (white arrows)

low rate to the use of TMJ surface coil and also to the fact that malignant tumours arising in this region are likely to cause significant functional and aesthetic disturbance. This was in keeping with our low rate ($n = 0$) of our series of incidental extracranial malignant tumours. Other non-neoplastic findings were at 5.7%.

The level of action required when discovering an incidental finding varies according to its clinical significance. Illes et al[16] classified incidental findings on adult brain MRI acquired for research purposes into the following categories.

- No referral necessary: common normal findings in asymptomatic subjects (*e.g.* minimal paranasal sinus disease). In our study, 39 cases fell into this category.
- Routine referral: *e.g.* acute sinusitis or non-specific white matter lesion. In our study, 13 cases fell into this category.
- Urgent referral required: within 1 week (*e.g.* non-acute intraparenchymal or extra-axial lesion other than small white matter focus). In our study, 1 case fell into this category.
- Immediate referral required: *e.g.* acute process with significant mass effect. No cases in our study fell into this category.

The impact on patients of incidental findings in any imaging modality has been discussed thoroughly in the literature in both clinical and research environments. Illes et al[16] also raised awareness about the need for anticipating incidental findings in research and for articulating a plan to handle them in both institutional review board materials and in consent forms for subject recruitment.

In a clinical setting, incidental findings do occur and as a result, communication with the referrer in a timely manner is important. Devine et al[26] found that the majority of incidental findings discovered on abdomen and pelvic CT scanning of trauma patients are not documented; therefore, many patients may not receive the appropriate recommended follow-up.

Urgent findings need to be communicated verbally, then in writing. Less urgent findings need to be correctly documented and communicated to the referrer.

There are guidelines available on the standards for the communication of critical, urgent and unexpected significant radiological findings published by the Royal College of Radiologists and in the Safer Practice Notice 16 published by the National Health Service National Patient Safety agency in the UK.[27,28] Both highlight recommendations for referrers, radiology departments, reporting radiologists and radiographers relevant to critical and urgent findings.

Although the clinically relevant incidental findings on MRI of the TMJs remain low, it is important to ensure that the full data set is inspected, including the scout images. Incidental findings should be communicated to the referring clinicians in a timely manner, based on their urgency and clinical significance.

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