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Incidental findings of temporomandibular joint disorders on standard brain MRIs

Azaria Simonovich[1]; Svetlana Kolontaevsky[1]; Leonid Kalichman[2]*

[1]Department of Radiology, Barzilai Medical Center, Ashkelon, Israel

[2]Department of Physical Therapy, Faculty of Health Studies, Ben Gurion University of the Negev, Beer Sheva, Israel

***Corresponding Author(s): Leonid Kalichman**

Department of Physical Therapy, Faculty of Health Studies, Ben Gurion University of the Negev, Beer Sheva, Israel

Email: kleonid@bgu.ac.il & kalichman@hotmail.com

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Keywords: Temporomandibular joint; Magnetic Resonance Imaging; Incidental findings; Temporomandibular joint dysfunction symptoms.

Abstract

Objective: To evaluate the prevalence of incidental temporomandibular joint findings on brain and orbit magnetic resonance imaging scans and assess if these findings are associated with symptoms.

Methods: Our sample comprised 64 males (46.4%) and 74 females (53.6%), mean age 54.75±17.45 (range: 18-87). Data collected from each temporomandibular joint included articular displacement, articular effusion, condyle flattering, condyle erosions, capsule enhancement, and bone marrow edema. Dichotomous data as to temporomandibular joint-related symptoms such as headaches, earaches, dizziness, clicking or grating sound, pain or soreness of the joint, limited mouth opening, locking of the jaw, facial muscle pain, unexplained teeth pain, neck pain or stiffness and difficulty swallowing, were acquired during telephone interviews.

Results: The most frequent finding was disc displacement (39.9% on the right side and 47.8% on the left), followed by condyle flattering (33.3% on the right side and 44.2% on the left). All findings, except bone marrow edema, were significantly more frequent on the left side than the right. Significant associations were found between incidental findings in the temporomandibular joint and earaches (odds ratio 2.759, P=0.043), dizziness (odds ratio 2.325, P=0.031), a clicking or grating sound (odds ratio 6.492, P=0.002) and facial muscle pain (odds ratio 11.255, P=0.003).

Conclusions: Incidental findings of temporomandibular joint degenerative features were commonly found on the brain and orbit magnetic resonance imaging. Incidental findings on the temporomandibular joint were associated with earaches, dizziness, a clicking or grating sound and facial muscle pain.

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Introduction

Neuroradiology research and physicians in clinical practice have increasingly used magnetic resonance imaging (MRI) in diagnosing illnesses. The higher resolution of these images increases the detection of unexpected anomalies [1]. These anomalies are generally called incidental findings and usually do not have any explicit symptoms or pathology. However, some findings may require further clinical evaluation and/or treatment [2,3].

In our experience, numerous incidental findings are found in the Temporomandibular joint (TMJ) after the patient had undergone a standard brain and orbit MRI scan, especially the elderly. Bernhardt et al [4] assessed the prevalence of degenerative TMJ changes in males and females aged 20-49 by clinical examination and MRI and found a prevalence of 25%. A detailed evaluation of TMJ anatomy can be viewed on an MRI because of its inherent tissue contrast and high-resolution. A literature search revealed that no studies have reported the prevalence of these findings or their clinical relevance.

Aims

1. To evaluate the prevalence of incidental TMJ findings on standard brain and orbit MRI scans.
2. To assess if incidental TMJ findings on brain and orbit MRIs are associated with symptoms.

Hypotheses

1. Incidental TMJ findings are prevalent in the brain and orbit MRI scans.
2. Incidental TMJ findings are associated with TMJ-related symptoms (pain, difficulties in mouth opening, etc.).

Methods

Design

Cross-sectional observational analytic study.

Setting

Department of Radiology, Barzilai Medical Center, Ashqelon, Israel.

Sample

Consecutive 138 patients referred to the brain and orbit MRI between 2017 and 2018. All MRI evaluations were performed due to vision-related complaints (diplopia, vision acuity disorders, etc.). The uniqueness if our sample is that brain and orbit MRI tests of various indications were included, so our protocol included standard brain series, fat-suppressed series and the injection of contrast material. This allowed us to go beyond previously described findings such as a disc or joints degenerative changes, but also evaluate the edema of the bone marrow and contrast enhancement of the joint capsule, the findings attributed to active inflammation.

Inclusion Criteria

Males and females were divided into two groups: patients aged 18-40 and patients >40 who were referred to the Department of Radiology, Barzilai Medical Center to undergo a brain and orbit MRI.

Exclusion Criteria

Facial or mandibular fractures known or detected on MRI, a previous TMJ operation, or an active rheumatic disease involving the TMJ.

Ethical Considerations

Since MRI scans were collected from the Department of Radiology's archives, no harm was caused to the patients. The study was approved by the Eths (Helsinki) Committee of the Barzilai Medical Center.

MRI parameters

An MRI was performed on all participants employing the same whole-body 1.5-T scanner (Ingenia, Philips, Nederland) with an NV 16-channel DS head coil, located at the Department of Radiology, Barzilai University Hospital, Ashqelon, Israel. All scans were conducted by a board-certified MRI technologist using our standard protocol for brain and orbit MRI. The acquisition protocol included T1-weighted spin-echo axial, T2-weighted turbo spin-echo axial, three-dimensional (3D), T1-weighted turbo gradient echo fat-suppressed sagittal and 3D, FLAIR (fluid-attenuated inversion recovery) and fat-suppressed turbo spin-echo sagittal with an MPR multiplanar reconstruction sequence covering the entire brain after contrast media injection.

Acquisition parameters for the imaging sequences were as follows:

1. T1-weighted spin-echo (SE) 2D used a repetition time (TR) of 500 ms, echo time (TE) of 15 ms, an acquisition matrix of 272 × 179 and a slice thickness of 5 mm which included 30 slices.
2. T2-weighted turbo spin-echo used a TR of 6045 ms, a TE of 100 ms, an acquisition matrix of 384 × 246 and a slice thickness of 5 mm which included 30 slices.
3. 3D FLAIR turbo spin-echo used a resolution of 1.15 × 1.15 × 0.7 mm, a TR of 4800 ms, a TE of 328 ms, an inversion time (TI) of 1660 ms, an acquisition matrix of 252 × 250 and a slice thickness of 0.7 mm which included 270 slices.
4. T1-weighted 3D turbo gradient echo used an isotropic resolution of 0.9 × 0.9 × 0.9 mm, a TR of 12.9 ms, a TE of 6.2 ms, an acquisition matrix of 252 × 250 and a slice thickness of 0.9 mm which included 190 slices. Fat suppression was applied.

TMJ disorder evaluation

An experienced radiologist, blinded to the clinical information and patient's identity, performed all MRI evaluations of TMJs using previously described methods [5,6]. The data collected included:

1. Articular displacement
2. Articular effusion
3. Condyle flattering
4. Condyle erosions
5. Capsule enhancement
6. Bone marrow edema

Reliability of MRI readings

LK, SK and AS read a batch of MRIs and developed a reading protocol for evaluating the studied parameters. Using this protocol, an SK read and re-read 20 MRIs, two weeks apart, blinded to the identity of the patient in order to assess the intra-rater reliability of the readings. The intra-observer reliability (κ) for detecting different TMJ incidental findings varied between 0.76 and 0.94. This range of kappa statistics represents good to excellent reproducibility.

Additional data collection

Demographic data (age, sex) were collected from medical records. Dichotomous data on TMJ-related symptoms were obtained by a telephone interview. Phone interviews were performed in a standardized way during the 2018 year. Some of the interviews were performed close to the date of MRI evaluation, but other interviews were up to one year after the evaluation. In cases when a long time passed since the MRI evaluation, subjects were asked to describe the symptoms that were present at the time of evaluation. The data included signs and symptoms commonly associated with TMJ disorders: headaches, earaches (including stuffiness or ringing), dizziness (lightheadedness), a clicking or grating sound, pain or soreness of the TMJ, limited mouth opening, locking of the jaw (open or closed), facial muscle (cheeks) pain, unexplained teeth pain, neck pain or stiffness and difficulty in swallowing (sore throat).

Statistical analysis

To characterize the sample, descriptive statistics were used. To evaluate the intra-rater reliability of the MRI evaluated variables, kappa coefficients were calculated. The prevalence of each type of incidental findings and TMJ associated disorders were calculated using frequency statistics. The Wilcoxon Signed Ranks Test was used to compare the frequencies of findings on both the left and right sides.

We summed all incidental findings for each TMJ side and used these scores (Rt-IF for the right side and Lt-IF for the left side) in analyzing the association with age (Pearson correlations). We then constructed a dichotomous variable of TMJ incidental findings. If Rt-IF>1 or Lt-IF>1, they were considered as affected. If one or both joints were affected, the TMJ incidental finding (TMJ-IF) was considered positive. To estimate the association between clinical TMJ-related symptoms and TMJ-IF on a standard brain MRI, logistic regression analyses were used with TMJ-related symptoms as dependent variables and incidental findings (dichotomous variables), age and sex as predictors.

Results

The study sample comprised 64 males (46.4%) and 74 females (53.6%). The mean age of subjects was 54.75±17.45 (range: 18-87). Frequencies of incidental findings in TMJs on a standard brain MRI are presented in Table 1. The most frequent finding was disc displacement (39.9% on the right side and 47.8% on the left), followed by condyle flattering (33.3% on the right side and 44.2% on the left). All findings, except for bone marrow edema were significantly more frequent on the left side than on the right. Frequencies of TMJ-related symptoms in the studied sample are presented in Table 2. The highest frequency was found in headaches (55.1%), followed by dizziness (lightheadedness) (46.5%) and neck pain or stiffness (37.0%).

Table 1: Frequencies of Incidental Findings in TMJs on Standard Brain MRI (n= 138).

Variables	Right	Left	Comparison*
Disc displacement	N=55 (39.9%)	N=66 (47.8%)	Z=-1.98, P=0.048
Articular effusion	N=5 (3.6%)	N=13 (9.4%)	Z=-2.14, P=0.033
Condyle flattering	N=46 (33.3%)	N=61 (44.2%)	Z=-2.89, P=0.004
Condyle erosion	N=13 (9.4%)	N=24 (17.4%)	Z=-2.20, P=0.028
Capsule enhancement	N=4 (2.9%)	13 (9.4%)	Z=-2.50, P=0.013
Bone marrow edema	N=11 (8%)	N=16 (11.6%)	Z=-1.51, P=0.132

*Results of Wilcoxon Signed Ranks Test; Significant differences (p<0.05) are marked in bold.

Table 2: Frequencies of Incidental Findings in TMJs on Standard Brain MRI (n= 138).

Symptoms	Frequency (N, valid percent)
Headache	70 (55.1%)
Earaches, stuffiness or ringing	26 (20.5%)
Dizziness, lightheadedness	59 (46.5%)
Clicking or grating sound in TMJ	26 (20.5%)
Pain or soreness of the TMJ	6 (4.7)
Limited mouth opening	0 (0.0%)
Locking jaw (open or closed)	0 (0.0%)
Pain in facial muscles (cheeks)	17 (13.4%)
Unexplained teeth pain	4 (3.1%)
Neck pain or stiffness	47 (37.0%)
Difficulty swallowing (sore throat)	12 (9.4%)

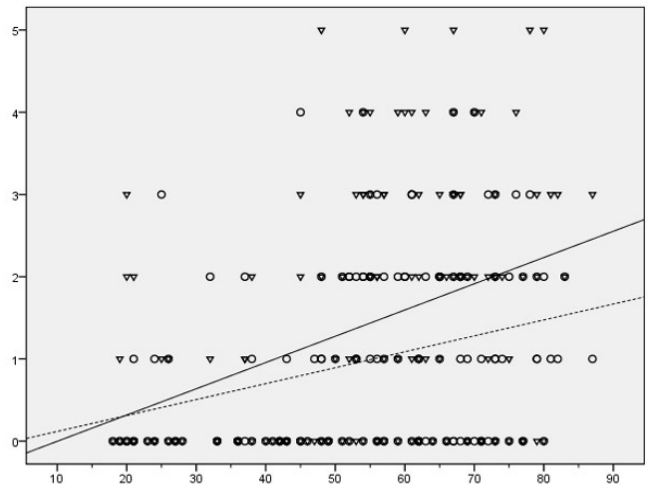

Figure 1: Scatterplot of association between age and incidental findings in right and left TMJ. Solid line – Lt-IF, dot-line – Rt-IF.

Table 3: Association between Clinical TMJ Related Symptoms and TMJ-IF on Standard Brain MRI *

Symptoms	B	p-value	Odds ratio
Headache	0.475	0.220	1.607
Earaches, stuffiness or ringing	**1.015**	**0.043**	**2.759**
Dizziness, lightheadedness	**0.844**	**0.031**	**2.325**
A clicking or grating sound	**1.871**	**0.002**	**6.492**
Pain or soreness of the TMJ	0.753	0.424	2.123
Pain in facial muscles (cheeks)	**2.421**	**0.003**	**11.255**
Unexplained teeth pain	1.736	0.169	5.676
Neck pain or stiffness	0.602	0.147	1.826
Difficulty swallowing (sore throat)	1.559	0.057	4.752

*Results of logistic regression analysis (d.f.=1) with the symptom as a dependent variable and TMJ-IF, age, and sex as independent predictors. A significant association ($p<0.05$) is marked in bold.

We found mild positive correlations between age and Rt-IF ($r=0.30$, $p<0.001$) and Lt-IF ($r=0.37$, $p<0.001$). The scatterplot of association is shown in Figure 1. The association between clinical TMJ-related symptoms and TMJ-IF on a standard brain MRI are shown in Table 3. A significant association was found between TMJ-IF and the following clinical TMJ-related symptoms: earaches (including stuffiness or ringing) (odds ratio 2.759, P=0.043), dizziness (lightheadedness) (odds ratio 2.325, P=0.031), a clicking or grating sound (odds ratio 6.492, P=0.002) and facial muscle pain (cheeks) (odds ratio 11.255, P=0.003).

Discussion

We studied the prevalence of specific types of incidental findings in TMJs found on brain MRI scans. The need to clarify the classification of normal versus abnormal findings has previously been raised [7] and remains an important topic for neuroradiologists to consider, as the use of brain MRI is continuously increasing among the elderly population.

In our study, we found a high prevalence of disc displacement, condyle flattering and a moderate prevalence of condyle erosion and bone marrow lesions in a sample of individuals referred to a standard brain MRI. Despite the sensitivity and specificity of an MRI in detecting disc position, the clinical implications of these findings must be interpreted with caution. For example, an anteriorly displaced disc can be seen in up to 34% of asymptomatic patients and a normal disc position can be seen in up to 23% of symptomatic patients [8,9].

All findings, except for bone marrow edema, were more frequent on the left rather than the right side. Mastication, performed predominantly on one side of the dentition, is known as a chewing-side preference [10]. Although mastication may occur bilaterally, it has been reported that the majority of people preferably chew on one side [10-12]. Some previous studies have shown no significant prevalence between a right- or left-side preference of mastication [10,11], while others have reported a predominance on the right-side [13-15]. We currently cannot explain why left side TMJs showed more degenerative changes than right-sided. It is possible that it is somehow associated with a chewing-side preference or that our findings are accidental. Additional studies are needed to clarify this point.

Mild positive correlations between age and Rt-IF ($r=0.30$, $p<0.001$) and Lt-IF ($r=0.37$, $p<0.001$) were observed. Age was found to be a predisposing factor for degenerative changes in the TMJ [16] because both the frequency and severity of the changes increase with age, i.e. the calcium content of the TMJ disc progressively increases with age [17], thus the disc becomes stiffer and more fragile, reducing its capability to handle the overload.

A significant association was found between TMJ-IF and the following clinical TMJ-related symptoms: earaches (including stuffiness or ringing), dizziness (lightheadedness), a clicking or grating sound and facial muscle pain (cheeks). Several previous studies have shown a significant correlation between TMJ clinical signs and symptoms and MRI findings in patients with TMJ disorders [18-20] and in the non-patient population [21]. The impact of incidental findings on employment, health, quality of life and medical costs is currently unknown. Similar problems as to incidental findings in research using genetic and laboratory techniques are presently being recognized [3,22]. Future studies should focus on determining the medical and associated implications [23] including the treatment and outcome of incidental findings of all ages [3].

Our study has several limitations. First, a number of subjects is relatedly limited. Second, the acquisition of patient complaints/symptoms through a phone interview was performed sometimes months after the imaging. This can be a source of recall bias. We reminded the patient the time of MRI evaluation and asked to describe the symptoms that were present at the time of evaluation. Still, the data on symptoms should be carried with caution.

Conclusion

In summary, incidental findings of TMJ degenerative features are quite common in brain MRIs. These findings occur more frequently on the left side of the TMJ and are significantly associated with age. Incidental findings on the TMJ were associated with earaches, dizziness, a clicking or grating sound and facial muscle pain.

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