Association between Arthralgia and Imaging Findings of Effusion in the Temporomandibular Joints: A Systematic Review

Abstract

Aims: A systematic review was conducted to determine if there is an association between joint effusion and self-reported TMJ-pain during examination and between joint effusion and arthralgia as defined by the Research Diagnostic Criteria for Temporomandibular Disorders (RDC-TMD).

Methods: Four reviewers separately identified observational studies evaluating a possible association between ipsilateral joint effusion, identified by MRI T2-weighted images, and TMJ pain by systematically searching three databases.

Results: A total of 67 articles were identified with the search strategy. However, 32 met the inclusion criteria for the systematic review.

Conclusion: Based on the review of 32 articles, published on this topic, body of literature was unable to provide evidence to support or refute the association between joint effusion and self-reported TMJ-pain, and between joint effusion and arthralgia as defined by RDC-TMD.

Keywords: Temporomandibular disorders; Joint effusion; MRI; Arthralgia; Pain

Introduction

The temporomandibular disorders (TMD) encompass a group of musculoskeletal and neuromuscular conditions that involve the temporomandibular joints (TMJs), the masticatory muscles, and associated tissues [1]. Common manifestations of TMD consist of pain of a persistent, recurring, or chronic nature in the TMJ, masticatory muscles, or in the adjacent structures; limitation or alteration in the range of mandible motion; and TMJ joint noises [2]. It has been suggested that diagnostic differentiation of TMDs should be based primarily on information obtained from the patient’s history, clinical examination, and TMJ imaging procedures indicated [1]. Magnetic resonance imaging (MRI) is an example of such imaging procedures. It provides excellent representation of soft tissues in anatomical and semi-functional relationships. In addition, it may also be used for detection of the presence of joint effusion with acceptable levels of reliability [3]. Some authors have also suggested use of MRI for assessment of hard tissues; however the reliability has been shown to be poor [3-5]. Joint effusion is defined as a collection of fluid in the joint space. It is manifested as areas of high intensity signal in the TMJ space, on T2-weighted images [3-5]. It has been suggested that this accumulation of fluid could be a surrogate of an inflammatory process that may activate or sensitize nociceptive afferent neurons within the joint [4-6]. Alternatively, it could result in increased intra-articular pressure, which may cause mechanical trauma, leading to hypoxia and other inflammation induced changes within the joint space, and eventually leads arthralgia [7]. Several studies have been conducted on the association of joint effusion and TMJ pain associated with TMD. However, the results have been inconsistent. While the majority of studies have reported a statistically significant association [4-26], others have reported inconclusive findings [5-30]. Due to this difference in reporting, a systematic review was conducted to determine if there is an association between joint effusion and self-reported TMJ-pain during examination, as well as between joint effusion and arthralgia as defined by the Research Diagnostic Criteria for Temporomandibular Disorders (RDC-TMD) [31].

Materials and Methods

The clinical question: “Is there an association between MRI identified temporomandibular joint effusion and self-reported TMJ-pain?” was utilized to guide the review.

a. Inclusion Criteria: Observational studies evaluating a
possible association between ipsilateral joint effusion, identified by MRI T2-weighted images, and TMJ pain were included. Manuscripts were limited to the English language only, published from inception till January 2017.

b. Exclusion Criteria: All investigations that included participants with rheumatologic diseases, or joint fractures were excluded. In addition, publications such as literature reviews and case-reports were also excluded from the review.

c. Literature Search: Four reviewers separately identified the pertinent literature by searching PubMed, MEDLINE and Cochrane databases under the inclusion criteria of all studies that have been conducted to determine an association between joint effusion and pain in the TMJ. The MeSH terms included TMJ, effusion, MRI, pain and arthralgia.

d. Procedure: Literature review was performed in accordance to PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). Four reviewers independently read the title and the abstract of all publications that matched the MeSH search terms. The reviewers met and developed a final list of publications to be read by consensus. Two reviewers read all the papers (SKN, RFGM); the other two reviewers (HC, YG) equally divided the number papers so that each paper was evaluated independently by three reviewers (Figure 1). Articles were reviewed based on the aim of the study, demographics, methodology, diagnostic criteria, MRI protocol, results, and conclusions.

Figure 1: Flow chart summarizing the process of literature search.
Results

Three databases (PubMed, Cochrane, and Medline) were systematically searched for articles. A total of 67 articles were identified based on the search strategy. Thirty-two met the inclusion criteria, and all were observational studies. Thirty-five publications were excluded because they did not evaluate the association of TMJ effusion with TMJ pain, did not use MRI to evaluate effusion, were case-reports, or literature review studies. The summary of 32 included articles is provided in Table 1. The majority of the included studies reported a statistically significant association between joint effusion and self-reported TMJ-pain. However, during the review of these studies, several methodological limitations were identified. For example: absence of control group [4-32]; lack of information about examiner or radiologist reliability [10-26]; failure to report details regarding the clinical examination [4-32]; joint pain assessed by self-report (history) only without a clinical examination [15]; or inappropriate statistical analysis [25]. Among the studies that failed to find an association between TMJ effusion and self-reported TMJ-pain, several methodological limitations were also present. These include inappropriate control groups [5-30]; lack of information about the evaluation of TMJ pain, or evaluation using a non-standardized examination [6-30]; or lack of information regarding examiner and radiologist reliability [6-30].

Table 1: Summary of the studies included in the systematic review on the association of TMJ effusion and TMJ pain.

<table>
<thead>
<tr>
<th>Author and Year</th>
<th>Study Aim</th>
<th>Demographics</th>
<th>TMJ Pain Assessment Methodology</th>
<th>Imaging Assessment Methodology</th>
<th>Statistics</th>
<th>Conclusion</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khawaja et al. [8]</td>
<td>Aim: To determine the clinical and radiological significance of JE in patients with TMD.</td>
<td>N= 158; 312 TMJs</td>
<td>59.4 % ♂, X</td>
<td>age: 31 ± 11.1 yrs.</td>
<td>40.6 % ♀</td>
<td>Study group: Participants underwent DC/TMD examination by calibrated examiners</td>
<td>T2-weighted sagittal sequences (1.5 T, 3mm thick cuts)</td>
</tr>
<tr>
<td>Oliveira et al. [4]</td>
<td>Aim: To evaluate the association between condylar bone changes and presence of TMJ effusion in symptomatic patients</td>
<td>N= 74 ; 148 TMJs</td>
<td>68.9 % ♂, X</td>
<td>age: 40.4 ± 14.5 yrs.</td>
<td>31.1 % ♀</td>
<td>Study group: Participants reported at least one sign or symptom of TMD during clinical examination</td>
<td>T2-weighted sagittal sequences (1.5 T, 3mm thick cuts)</td>
</tr>
<tr>
<td>Lamot U et al. [14]</td>
<td>a. To determine correlation between MRI and clinical findings associated with TMD. b. To assess the impact of gender and age, on this correlation.</td>
<td>N= 104 ; 288 TMJs</td>
<td>57.7 % ♂, 24.3 % ♀</td>
<td>Total sample</td>
<td>X age: 39.4 yrs. (12 – 81 yrs.).</td>
<td>Study group: Participants had unilateral or bilateral presence of TMJ pain, noises/clicking, limited movement and headache. Study group was divided into 3 sub-groups based on type of ID.</td>
<td>T2-weighted sagittal sequences (1.5 T, 20 slices)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Aim</th>
<th>Study Group</th>
<th>Total Sample</th>
<th>Study Details</th>
<th>T2-Weighted Sagittal Sequences</th>
<th>Prevalence</th>
<th>Association</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santos et al. [20]</td>
<td>To assess the association between changes of the articular eminence and the condyle, articular disc changes, and the presence of TMJ effusion in symptomatic patients.</td>
<td>N = 71 ; 142 TMJs 69 % ♀ ; 31 % ♂ Total sample = X age: 38.7 yrs. (13 – 69 yrs.).</td>
<td>Study group: Participants reported at least one sign or symptom of TMD during examination</td>
<td>T2-weighted sagittal sequences (1.5 T; 3mm thick cuts) JE defined: any hyper-signal in the articular space. Two radiologist, diagnosis by consensus</td>
<td>Prevalence Pearson’s Chi-Square test Fisher’s exact test</td>
<td>Association was present between: 1) disc form and its position; 2) condylar form and an anterior portion of disc; and 3) articular eminence form and disc form. Prevalence of JE in symptomatic joints was 23.9 %.</td>
<td>No control group Clinical examination not adequately described. Reliability of clinical examiners and radiologists was not described.</td>
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</tr>
<tr>
<td>Park et al. [18]</td>
<td>To investigate the value of MRI in the diagnostic process based on the RDC/TMD.</td>
<td>N = 100 ; 200 TMJs 68.0 % ♀ with X age: 25.3 ± 13.12 yrs. 32 % ♂ with mean age: 31.9 ± 12.3 yrs.</td>
<td>Study group: Participants underwent RDC/TMD examination. Study group was divided into 3 distinct Group II diagnoses based on RDC/TMD.</td>
<td>T2-weighted sagittal sequences (1.5 T) JE defined: any high intensity signal in articular surface or compartment. Two radiologist, diagnosis by consensus Radiologist underwent calibration.</td>
<td>Cohen's Kappa Chi-Square test</td>
<td>Cohen’s Kappa showed no agreement to moderate agreement between MRI and Group II diagnosis based on RDC/TMD JE and ipsilateral pain were significantly associated. 43.4 % of joints with pain had JE while 28.7 % of non-painful joints had JE</td>
<td>No information if radiologists were blind to the clinical diagnosis Reliability of clinical examiners and radiologists was not reported.</td>
<td></td>
</tr>
<tr>
<td>Bas et al. [9]</td>
<td>To evaluate the relationship between the grades of MRI depicted JE, increased capsular width (CW) measured in Ultrasonographic Imaging (USI), and joint pain.</td>
<td>N = 91 ; 102 TMJs 81.3 % ♀ 18.7 % ♂ Total sample = X age: 25 yrs.</td>
<td>Study group: Participants underwent a. RDC/TMD examination. b. VAS to measure pain intensity.</td>
<td>T2-weighted sagittal sequences (0.5 T; 3mm thick cuts) JE defined: area of homogenous and high signal intensity. JE was characterized into moderate and severe effusion. CW was assessed by USI</td>
<td>Receiver Operating Characteristic curve Friedman Test Wilcoxon Test</td>
<td>Cutoff value for CW was calculated to be 1.65 mm Statistically significant association was found between VAS score and intensity of MRI- JE. JE absent: 2.55 VAS Moderate JE: 2.92 Severe JE: 4.80</td>
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<tr>
<td>Kaneyama et al. [13]</td>
<td>To determine the association between JE and various soluble cytokine receptors in the synovial fluid.</td>
<td>N = 55 ; 55 TMJs</td>
<td>Study group: Participants had diagnosis of TMD based on a. Clinical symptoms and MRI. b. VAS used to measure ipsilateral joint pain intensity.</td>
<td>T2-weighted sagittal sequences (1.5 T; 3mm thick cuts) JE defined: area of high intensity signal in superior compartment. JE was characterized into grade I, II, and III based on the quantity of signal. Three radiologist, diagnosis by consensus.</td>
<td>Mann-Whitney U test Spearman’s correlation</td>
<td>The mean concentration of cytokine receptors in the synovial fluid were significantly higher in joints with JE than in joints without JE. JE was reported in 55.5 % joints. No statistically significant difference was observed between severity of JE and VAS. Gender and age demographics not provided. Clinical examination was not adequately described. Reliability of clinical examiners and radiologists was not described. High signal in the inferior TM joint compartment was not considered as indicative of JE.</td>
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</tbody>
</table>

**Association between Arthralgia and Imaging Findings of Effusion in the Temporomandibular Joints: A Systematic Review**

**Nakaoka et al. [32]**

**Aim:** To investigate the changes of JE on the MRI and pathology observed in arthroscopy after VGR.

- **a.** To correlate these findings with clinical variables.

<table>
<thead>
<tr>
<th>Study group</th>
<th>N = 56; 56 TMJs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants who underwent clinical examination. Study group had a clinical diagnosis of unilateral chronic closed lock.</td>
<td></td>
</tr>
</tbody>
</table>

**T2-weighted sagittal sequences (0.3 T)**

- JE defined: area of high signal intensity.
- JE characterized into grade I, II, and III. Three radiologist, diagnosis by consensus.

**Wilcoxon signed-rank sum test**

- Spearman’s correlation

**Costa et al. [10]**

**Aim:** To assess the correlation of TM joint ID in patients with the presence of headache, bruxism, and joint pain using MRI.

<table>
<thead>
<tr>
<th>Study group</th>
<th>N = 58; 58 TMJs</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMD group: 42 participants, 83.3 % ♂, 16.7 % ♀. Age range of 16-83 yrs.</td>
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</tr>
<tr>
<td>Control group: 16 participants, 68.8 % ♂, 31.2 % ♀. Age range of 26-37 yrs.</td>
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</tr>
</tbody>
</table>

**Study group:** Participants underwent MRI examination by a calibrated examiner.

**T2-weighted sagittal sequences (2 T, 1.5 mm thick cuts)**

- JE defined: area of high signal intensity in the region of upper and lower joint spaces.

**Chi-square test**

- Fisher’s exact test

**Farina et al. [28]**

**Aim:** To evaluate the association between conventional and enhanced MRI findings, and TMJ pain.

<table>
<thead>
<tr>
<th>Study group</th>
<th>N = 38; 78 TMJs</th>
</tr>
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<tbody>
<tr>
<td>Participants had TMJ pain and dysfunction. Control group: Participants did not have any TMJ pain or dysfunction.</td>
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</tbody>
</table>

**T2-weighted sagittal sequences (1.5 T, 3 mm thick cuts)**

- JE defined: presence of high signal intensity within joint space in open- or closed-mouth images.

**Chi-square test**

- Multivariate logistic regression analysis.

**Limchaichana et al. [5]**

**Aim:** To evaluate the association between MRI findings and clinical symptoms of TMD.

<table>
<thead>
<tr>
<th>Study group</th>
<th>N = 60; 120 TMJs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants underwent RDC/TMD examination by a calibrated examiner. Divided into a. Myofascial pain only. b. Myofascial pain with Arthralgia/OA.</td>
<td></td>
</tr>
</tbody>
</table>

**T2-weighted sagittal sequences (1.5 T)**

- JE defined: area of more than a line or dots of high signal intensity in the region of superior or inferior joint space.

**Chi-square test**

- Fisher’s exact test Kappa statistic

**Limchaichana et al. [5]**

**Aim:** To evaluate the association between MRI findings and clinical symptoms of TMD.

<table>
<thead>
<tr>
<th>Study group</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Participants underwent RDC/TMD examination by a calibrated examiner. Divided into a. Myofascial pain only. b. Myofascial pain with Arthralgia/OA.</td>
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</tr>
</tbody>
</table>

**T2-weighted sagittal sequences (1.5 T)**

- JE defined: area of more than a line or dots of high signal intensity in the region of superior or inferior joint space.

**Chi-square test**

- Fisher’s exact test Kappa statistic

**T-test**

- Chi-square test

### Association between Arthralgia and Imaging Findings of Effusion in the Temporomandibular Joints: A Systematic Review

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample Size</th>
<th>Age Range</th>
<th>Sex Distribution</th>
<th>Joint Space Evaluation</th>
<th>Image Sequences</th>
<th>Diagnosis Method</th>
<th>Chi-Square Test</th>
<th>Reliability</th>
<th>Clinical Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guler et al. [29]</td>
<td>N = 31; 31 TMJs</td>
<td>17-64 yrs</td>
<td>♂ 48.7% ♀ 51.3%</td>
<td>JE; OA; DDwoR</td>
<td>T2-weighted sagittal sequences (1.5 T, 3 mm thick cuts)</td>
<td>MRI diagnosis</td>
<td>Chi-square Spearman’s rank correlation</td>
<td>Small sample size. Mean age of the participants is younger than the mean age of patients with TMD. Clinical examination was not adequately described. Reliability of clinical examiners and radiologists was not described.</td>
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</tr>
<tr>
<td>Yano et al. [30]</td>
<td>N = 17; 34 TMJs</td>
<td>12-69 yrs</td>
<td>♂ 55.9% ♀ 44.1%</td>
<td>JE; OA; DDwoR</td>
<td>T2-weighted sagittal sequences (1.5 T, 3 mm thick cuts)</td>
<td>MRI diagnosis</td>
<td>Chi-square test</td>
<td>No significant association observed between quantity of joint fluid and grade of ID. Significant difference was observed between presence of pain and the quantity of joint fluid.</td>
<td></td>
</tr>
<tr>
<td>Emshoff et al. [33]</td>
<td>N = 164; 164 TMJs</td>
<td>12-69 yrs</td>
<td>♂ 52.2% ♀ 47.8%</td>
<td>JE; OA; DDwoR</td>
<td>T2-weighted sagittal sequences (1.5 T, 3 mm thick cuts)</td>
<td>MRI diagnosis</td>
<td>Chi-square test Multiple logistic regression analysis</td>
<td>DJD diagnosis was diagnosed using a clinical examination.</td>
<td></td>
</tr>
<tr>
<td>Emshoff et al. [34]</td>
<td>N = 42; 84 TMJs</td>
<td>16-77 yrs</td>
<td>♂ 55.8% ♀ 44.2%</td>
<td>JE; OA; DDwoR</td>
<td>T2-weighted sagittal sequences (1.5 T, 3 mm thick cuts)</td>
<td>MRI diagnosis</td>
<td>Chi-square test Multiple logistic regression analysis</td>
<td>Primarily clinical symptoms used without confirming the diagnosis of arthralgia. Reliability of radiologists was not described.</td>
<td></td>
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</table>

### Guler et al. [11]

**Aim:** To correlate MRI findings of JE, disc displacement, condylar bone changes and disc form with clinical findings of pain and sounds in patients with bruxing behavior.

- **N:** 94; 188 TMJs
- **Study (bruxing) group:** 86.7 % ♀ and 13.3 % ♂.
- **Control group:** 86.7 % ♀, 13.3 % ♂.
- **X age:** 29 yrs. (13 - 63 yrs).

**Study group:** Participants underwent examination for:
- a. TMJ pain and dysfunction.
- b. Bruxism.
- c. VAS to measure pain intensity.

**T2-weighted sagittal sequences (1.5 T, 3 mm thick cuts)**

- **JE defined:** area of high signal intensity in the region of the upper and lower joint spaces.

**Chi-Square**

- **Significantly higher prevalence** of condylar bony changes present in joints with displaced disks in the study group.
- **Significant association** was present between JE and TMJ pain.

- **30 % of painful joints** in the study group, and **59 % of the painful joints** in the control group had JE.

**Data of the subjects included in the analysis were meeting the exclusion criteria. Reliability of clinical examiners was not described.**

### Yamamoto et al. [25]

**Aim:** To evaluate the association between quantity of JE and TMD associated pain and dysfunction.

- **N:** 293; 577 TMJs
- **Study group:** Participants had TMD pain and dysfunction.

**T2-weighted sagittal sequences (1 T/1.5 T)**

- **JE defined:** high-signal area in the upper and lower joint spaces.
- ** JE was characterized into 4 levels.**

**Kruskal-Wallis test Scheffe test Wilcoxon rank sum**

- **Statistically significant difference** was present for JE, between painful and non-painful joints in the DDwoR group.
- **No statistically significant difference** was present in painful and non-painful joints of normal, DDwR, or OA groups.

**Clinical examination was not adequately described. Radiologists were not blind to the clinical diagnosis. Reliability for the quantification criteria for JE not provided. Inappropriate statistical analysis Radiologists were not blind to the clinical diagnosis.**

### Emshoff et al. [35]

**Aim:** To determine if MRI findings are predictive of TMJ pain.

- **N:** 169; 338 TMJs
- **Study group:** Participants underwent CDC/TMD examination.

**T2-weighted sagittal sequences (1.5 T, 3 mm thick cuts).**

- **Intra observer reliability was determined (K ≥ .75 and K = 1.0).**

**Chi-square test Multiple logistic regression analysis**

- **In multiple logistic regression analysis, ID was significantly associated with TMJ pain; however, OA, JE, and bone marrow edema were statistically not significant. JE was observed in 44.2 % of painful TMJs, and 28.3 % non-painful TMJs A statistically significant correlation was present between TMJ pain and JE.**

According to multiple logistic model, JE is not associated with TMJ pain, while according to Chi-square test it is.
<table>
<thead>
<tr>
<th>Study</th>
<th>Aim</th>
<th>Study Group</th>
<th>T2-Weighted Sagittal Sequences (0.5 T, 3 mm Thick Cuts)</th>
<th>Multiple Logistic Analysis</th>
<th>Goodness-of-fit Test</th>
<th>Model Chi-square Test</th>
<th>Multiple Logistic Analysis</th>
<th>Goodness-of-fit Test</th>
<th>Model Chi-square Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manfredini et al. [16]</td>
<td>To evaluate the predictive value of clinical symptoms for MRI findings of JE.</td>
<td>N = 61</td>
<td>JE defined: area of high signal intensity inside the joint space.</td>
<td>Goodness-of-fit test</td>
<td>Chi-square test</td>
<td>Multiple logistic analysis</td>
<td>Goodness-of-fit test</td>
<td>Chi-square test</td>
<td>Multiple logistic analysis</td>
</tr>
<tr>
<td>Emshoff et al. [36]</td>
<td>To evaluate the association between MRI findings of OA, and/or JE, and TMJ pain.</td>
<td>N = 112 ; 224 TMJs</td>
<td>JE defined: area of more than one high signal intensity line in the region of joint space, evident in at least two consecutive sections.</td>
<td>Chi-square test</td>
<td>Kappa statistic test</td>
<td>Multiple logistic analysis</td>
<td>Goodness-of-fit test</td>
<td>Chi-square test</td>
<td>Multiple logistic analysis</td>
</tr>
<tr>
<td>Segami et al. [30]</td>
<td>To evaluate the association between JE and synovial fluid constituents in patients with ID and OA.</td>
<td>N = 108 ; 108 TMJs</td>
<td>JE defined: high-signal area in the upper and lower joint spaces. It was further characterized into 4 levels depending on quantity of joint fluid. Grade 0 and 1 were excluded.</td>
<td>Mann-Whitney U test</td>
<td>No statistically significant difference was observed in pain intensity among study groups. Joints with JE had significantly higher total protein concentration, and Interleukin – 6 levels than joints without JE.</td>
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<tr>
<td>Study</td>
<td>Aim</td>
<td>Methodology</td>
<td>Findings</td>
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<tr>
<td>Tanaka et al. [23]</td>
<td>a. To compare JE evaluation between T2-weighted MRI and Fat saturation (FS) MRI. b. To determine association between JE and MRI findings.</td>
<td>Study group: Participants underwent RDC/TMD examination. FS T2-weighted sagittal sequences (1.5 T, 3 mm thick cuts). JE defined: area of high signal intensity greater than a moderate amount of fluid.</td>
<td>Detection rate of JE by FS was significantly greater than by T2-weighted MRI. Statistically significant association between JE and TMJ pain. Kappa test indicates good agreement between pain and JE (Κ = 0.66). FS indicates 70 % of painful joints and 3 % of pain-free joints having JE.</td>
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<td>Haley et al. [12]</td>
<td>Aim: To investigate the association between TMJ-Pain and clinical and MRI findings.</td>
<td>Study group: Participants underwent standardized clinical examination. Examiners had acceptable levels of reliability.</td>
<td>OR for this association was 3.8. 80 % of joints with pain had ID (p = .332). OR for this association was 1.8. 84 % of joints with pain had reported experiencing pain at the onset of study (p = .001). OR for this association was 49.</td>
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<tr>
<td>Rudisch et al. [19]</td>
<td>Aim: To investigate the association between TMJ-Pain and MRI findings of ID and JE.</td>
<td>a. Study group: Participants underwent CDC/TMD examination. T2-weighted sagittal sequences (1.5 T, 3 mm thick cuts) JE defined: area of more than one high signal intensity line in the region of joint space, evident in at least two consecutive sections.</td>
<td>80.5 % of joints with pain and 46.3 % of joints without pain had ID. 58.5 % of joints with pain and 26.8 % of joints without pain had JE. ID and JE were statistically associated with TMJ-Pain. TMJ-Pain and ID had a K value of 0.34 (poor). TMJ-Pain and JE had a K value of 0.32 (poor).</td>
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<table>
<thead>
<tr>
<th>Study</th>
<th>Aim</th>
<th>Participants</th>
<th>JE Diagnosis</th>
<th>Statistical Analysis</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segami et al. [6]</td>
<td>Aim: To characterize JE with arthroscopic findings</td>
<td>N = 47 ; 47 TMJs 93.6 % ♂, 6.4 % ♀; X age: 39 yrs. (13-76 yrs.)</td>
<td>JE defined: high-signal area in the upper and lower joint spaces. JE was characterized into 4 levels. Grade 0 and 1 were excluded.</td>
<td>Mann-Whitney U test Spearman’s correlation coefficient</td>
<td>68.1 % of joints had JE. VAS score had no statistical correlation with the presence of JE.</td>
</tr>
<tr>
<td>Shaefer et al. [7]</td>
<td>Aim: a. To evaluate the association between TMJ arthralgia and JE. b. To evaluate the validity of 1 pound of palpating pressure for diagnosing arthralgia.</td>
<td>N = 30 ; 30 TMJs; X age of study group: 31.3 ± 9 yrs.; X age of control group: 31.6 ± 6 yrs.</td>
<td>JE defined: presence of any high intensity signal within either joint space. Reliability of the radiologist to determine JE was K = 0.85.</td>
<td>Sensitivity and Specificity T-test Paired t-test</td>
<td>85 % of subjects with TMJ arthralgia had JE. 72 % of subjects without any TMJ pain had JE. MRI effusion sensitivity was 85 %, and specificity was 28 %. Sensitivity and specificity of 1 pound of palpating pressure was 27 % and 100 %, respectively. All subjects were ♀. The criterion for TMJ arthralgia was not consistent with RDC/TMD specifications. Use of the most painful joint instead of both or an average.</td>
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<tr>
<td>Suenaga et al. [21]</td>
<td>Aim: To evaluate the association between JE, contrast enhancement of JE, nitric oxide present in the joint, and TMD symptoms.</td>
<td>N = 77 ; 154 TMJs; 84.6 % ♂, 15.4 % ♀; Age range was 14 – 70 yrs.</td>
<td>JE defined: area of high signal intensity in the region of the superior space.</td>
<td>Chi-square test Spearman’s rank correlation</td>
<td>56 % of symptomatic TMJs and 9 % of non-symptomatic TMJs had JE. JE was significantly associated with pain, and joint sounds. Contrast enhancement of JE was significantly higher in the symptomatic groups than T2-weighted images. Reliability of clinical examiners and radiologists was not described. Clinical diagnosis was based on non-standardized examination. High signal in the inferior TM joint space was not considered as indicative of JE.</td>
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<tr>
<td>Study</td>
<td>Aim</td>
<td>Participants</td>
<td>Study group</td>
<td>Diagnostic Criteria</td>
<td>Statistical Analysis</td>
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<td>Larheim et al. [15]</td>
<td>Aim: To evaluate the association between JE and MRI diagnosis of TMJ ID, bone marrow abnormalities, and pain.</td>
<td>N = 523</td>
<td>Participants underwent evaluation by a questionnaire.</td>
<td>T2-weighted sagittal sequences (1.5 T, 3 mm thick cuts). JE defined: area of high signal intensity greater than a moderate amount of fluid.</td>
<td>T-test Fisher's exact test Regression analysis</td>
</tr>
<tr>
<td>Takahashi et al. [22]</td>
<td>Aim: To investigate the association between JE, joint pain, and protein levels in joint lavage fluid of patients with ID and OA.</td>
<td>N = 26 ; 38 TMJs 84.2% ♂, 15.8% ♀</td>
<td>Study group: Participants underwent clinical examination.</td>
<td>T2-weighted sagittal sequences (1.5 T, 5 mm thick cut). JE defined: area of high signal intensity in the region of the superior or inferior joint space.</td>
<td>Fisher's exact test Student's t-test</td>
</tr>
<tr>
<td>Adame at al. [27]</td>
<td>Aim: To correlate JE with clinical and MRI findings.</td>
<td>N = 142 ; 169 TMJs 88.9% ♂, 11.1% ♀</td>
<td>Study group: Participants underwent clinical examination.</td>
<td>T2-weighted sagittal sequences (0.5T, 5 mm thick slices). JE defined: hyper-intensity signal in either joint space, seen in two consecutive image cuts.</td>
<td>Pearson’s Chi-square test</td>
</tr>
<tr>
<td>Murakami et al. [17]</td>
<td>Aim: To investigate the association between TMJ pain levels and JE.</td>
<td>N = 19 ; 19 joints</td>
<td>Study group: Participants underwent a. Clinical examination. b. VAS and Pain level questionnaire to measure intensity of pain.</td>
<td>T2-weighted sagittal sequences (1.5 T). JE defined: area of more than a line of high signal intensity in the region of superior or inferior joint space.</td>
<td>Paired t-test</td>
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</table>

Discussion

A systematic review was conducted to determine if there is an association between joint effusion, self-reported TMJ pain and arthralgia of the TMJ. Based on the review of 32 articles published on this topic, the body of literature was unable to provide evidence to support or refute the association between joint effusion and self-reported pain TMJ pain during examination or between joint effusion and arthralgia, as defined by RDC-TMD. Systematic review of the studies indicated that the majority of investigations had reported a statistically significant association between joint effusion and TMJ self-reported pain during examination and joint effusion and arthralgia as defined by RDC-TMD. However, these results need to be interpreted with caution due to the presence of several crucial methodological limitations. Some of these studies failed to apply a standardized clinical examination [4-36]. This may result in failure to identify the true source of pain associated with TMD, or may result in using indeterminate classifications, such as the inclusion of participants with “tenderness” to palpation instead of “pain”, or inclusion of participants with pain of muscular origin rather than of the TMJ. Furthermore, some investigations failed to report the reliability of the clinical examiners and radiologists [10-26]. Reliability is the overall consistency of a measure and is considered an important factor in identification of TMD and MRI-based findings since the prevalence of both conditions in the normal population range relatively low [31], and overlooking reliability may influence the results in favor of a false positive association and inconsistent reporting. Another reason for disparity in reporting may be due to poor consensus among the authors for the operational definition of joint effusion. Some of the investigators defined effusion as presence of a high intensity signal on T2 images only in the superior joint space, while other considered presence of a high intensity signal in the superior or inferior joint space as indicative of joint effusion. Similarly, some authors quantified the joint effusion into multiple relative categories. However, none of these investigations reported the reliability and validity of radiologist to quantify effusion, which limits the utility of this measure. Nonetheless, among the studies reporting quantification of effusion, the results were not consistent.

Conclusion

In summary, based on the findings of this systematic review, the association between MRI diagnosis of joint effusion and self-reported TMJ-pain as well as between joint effusion and arthralgia, as defined by RDC-TMD, was not determined. This may be attributed to several methodological limitations, and heterogeneity in the operational definition of joint effusion. Investigations using validated and reliable clinical and radiologic criteria with appropriate case and control groups that have been adequately characterized are required. This will help determine, if any, association is present between MRI diagnosis of joint effusion and joint pain, and joint effusion and arthralgia.

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References


