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The relationship between temporomandibular joint effusion and pain in patients with internal derangement

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ABSTRACT

Objectives: The purpose of this study was to evaluate the relationship between temporomandibular joint (TMJ) effusion and joint pain in patients with internal derangement based on the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD).
Methods: A total of 240 TMJs from 120 patients with unilateral painful joints (103 females and 17 males, mean age 29.9 ± 12 years) were evaluated. Clinical assessments were carried out according to the DC/TMD guidelines. Magnetic resonance imaging (MRI) was used to evaluate the degree of effusion in each joint. The radiological and clinical findings were analysed for statistically significant correlations.
Results: Although the results indicated a statistically significant association between moderate joint effusion and disc displacement ($p < 0,05$), there was no statistically significant association between moderate effusion and joint pain ($p > 0,05$). There were, however, statistically significant associations between marked effusion and both disc displacement and joint pain ($p < 0,05$).
Conclusion: TMJ effusion is associated with both disc displacement and joint pain: the effusion increased in direct proportion to the severity of pain and disc displacement. The possibility that there are various aetiologies for the condition should also be considered.

1. Introduction

Temporomandibular disorder (TMD) is an umbrella term for a group of musculoskeletal disorders that affect the joints and support systems around the temporomandibular joint (TMJ) (Carlsson, 1999). The most common type of TMD is TMJ internal derangement (ID). ID denotes the abnormal position of the joint disc in relation to the mandibular condyle and articular eminence (Bronstein et al., 1981; Katzberg et al., 1996; Tasaki et al., 1996). The prevalence of ID in TMD patients is reportedly between 77% and 89%, while its prevalence in asymptomatic individuals ranges from 30 to 39% (Bronstein et al., 1981; Tasaki et al., 1996). While the most frequent form is anterior disc displacement with reduction (ADDWR), characterized by a click, this is followed by anterior disc displacement without reduction (ADDWOR) (Dworkin and LeResche, 1992; Miernik and Wieckiewicz, 2015).

With advancements in magnetic resonance imaging (MRI) techniques, it has become possible to detect inflammatory changes in the TMJ and studies have shifted to focus on synovial fluid changes. The detection of changes in synovial fluid and pathologies enhances our understanding of the internal disorders that affect the TMJ (Gynther et al., 1994). High signal intensity in the TMJ, as seen in T2-weighted spin-echo sequences, is termed effusion by radiologists. These high-intensity signals are linked to changes in the amount of synovial fluid in the intra-articular compartments, the thickening of the walls of capillaries, veins, and arteries adjacent to retrodiscal tissues, and extravasation to the retrograde connective tissue of erythrocytes, together with the increased accumulation of blood (Javier et al., 1986; Isberg et al., 1986).

Several studies have used effusion imaging to examine intra-articular irregularities, pain, and dysfunction (Westesson and Brooks, 1992; Murakami et al., 1996; Yano et al., 2004; Park et al., 2012). In some of these studies, a relationship between intra-articular irregularity, pain, and dysfunction was detected, while others concluded that there was no correlation (Sano and Westesson, 1995; Murakami et al., 1996; Yano et al., 2004; Khawaja et al., 2017). Discussions on this subject are ongoing. Understanding the causes of TMJ dysfunction and effusion formation

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is crucial for accurate diagnosis and appropriate treatment strategies.

The relationships between anterior disc displacement (ADD) and joint effusion and degenerative changes have been discussed in earlier studies (Westesson and Brooks, 1992; Murakami et al., 1996; Yano et al., 2004; Park et al., 2012), but the updated Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) (Schiffman et al., 2014) have hitherto not been fully examined. The purpose of this study was to evaluate the relationship between clinical diagnoses based on DC/TMD and MRI findings in relation to TMJ ID.

2. Materials and methods

The study was approved by the Clinical Research Ethics Committee of Kocaeli University (KÜ GOKAEK, 2018/78). Participants were recruited from patients attending the Department of Oral and Maxillofacial Surgery, Kocaeli University, Turkey, from January 2014 to July 2018, who were seeking treatment for TMD. A total of 184 patients' data records with information from completed DC/TMD forms and bilateral MRIs were available. Data from 64 patients were excluded from the study since they did not comply with the study's criteria. Therefore, a total of 120 patients (103 females, 17 males; mean age 29.9 ± 12; range 18–59) were included in the study, with a total of 240 TMJs evaluated.

The inclusion criteria consisted of unilateral, painful TMD with ADDWR, ADDWOR with limited opening, and ADDWOR without limited opening, based on DC/TMD (Schiffman et al., 2014). The contralateral pain-free TMJs of the patients' were evaluated as the control group. The MRI scans of patients with major deformities, prior TMJ surgery, TMJ fractures, the presence of a known connective tissue or autoimmune disease, degenerative joint disease, osteoarthritis, condylar hypoplasia/hyperplasia/tumors, concurrent use of steroids, narcotics, or muscle relaxants were excluded from the study.

Clinical assessments were carried out according to the DC/TMD guidelines. A visual analog scale (VAS, 0–10) was used to determine the quantification of pain, assessing the severity of pain experienced during mandibular movement. MRI scans were captured, and two radiologists unapprised of the clinical diagnoses assessed the TMJ effusions based on the scans by consensus.

All MRI scans were captured using a 0.5 T MRI scanner (SIGNA; General Electric, Inc. Milwaukee, WI, USA) with a 6 x 8-cm diameter surface coil, a 15-cm field of view, and 256 × 192 or 256 × 256 matrices. Section thickness was 3 mm. T2-weighted images were captured at 1500/20 ms or 1500/80 ms repetition time (TR)/echo time (TE), and T1-weighted images at between 200/11 ms TR/TE and 340/17 ms TR/TE. Oblique sagittal and oblique coronal MRI images were obtained to facilitate improved visualization of the disc/condyle relationship.

The MRI scans were used to determine the degree of TMJ effusion. The degree of joint effusion in the upper and lower compartments visible from the MRI scans (as mentioned in a study by Bas et al. (2011)) was divided into three grades: Grade 0: no effusion (joint without effusion); Grade 1: moderate effusion (joint with high linear density on the joint surfaces; Fig. 1A); Grade 2: marked effusion (joint with localized concentration in the lower and upper joint spaces and containing retrodiscal tissues; Fig. 1B).

The patients' age, gender, degrees of TMJs effusion, disc displacements and VAS findings were evaluated statistically.

2.1. Statistical Analysis

SPSS for Windows version 20.0 (SPSS Inc., Chicago, IL, USA) was used for the statistical analyses. One-way ANOVA was used to investigate whether the VAS scores obtained in the study differed significantly according to ADD and the effusion parameters. The Tukey test was used to determine which group caused the difference if a significant difference was found among the groups based on the One-Way ANOVA. Chi-square analysis was performed to determine the relationship between categorical variables such as ADD, and effusion. The analyses were conducted at a 95% confidence level. A p-value of <0.05 was considered statistically significant.

3. Results

The disc displacements and effusion degrees, as seen in 120 painful and 120 painless joints, are shown in Fig. 2. Of the 120 painful TMJs, 66 joints had ADDWR and 54 had ADDWOR. Evaluation of the effusions revealed that 21 joints were Grade 0, 39 joints were Grade 1, and 60 joints were Grade 2. Of the 120 painless TMJs, 6 joints had no ADD, 84 had ADDWR, and 30 had ADDWOR. Evaluation of the effusions revealed that 45 joints were Grade 0, 54 joints were Grade 1, and 21 joints were Grade 2.

3.1. The correlation between joint effusion and ADD

Effusion was absent from 50% of the joints and marked effusion was present in 50% of those without ADD. Of those with ADDWR, no effusion was present in 34%, moderate effusion was present in 40%, and marked effusion was present in 26%. Of those with ADDWOR,

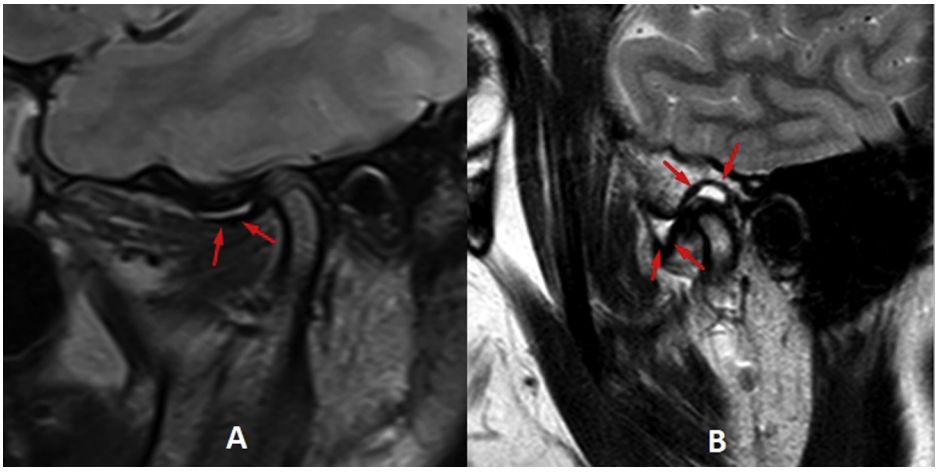

Fig. 1. A) TMJ moderate effusion (1) is seen on MRI **B)** TMJ marked effusion (2) is seen on MRI.

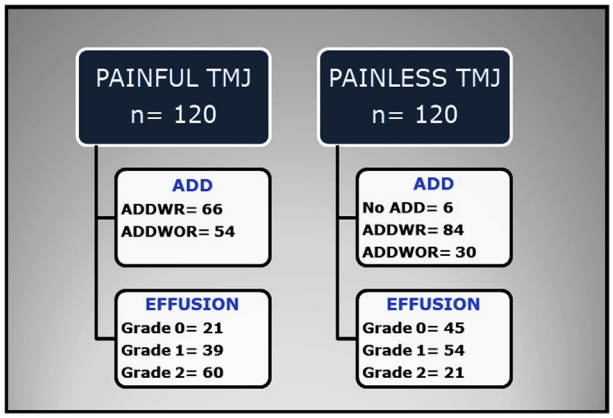

Fig. 2. Diagram of disc displacements and effusion degrees in painful and painless joints.

no effusion was present in 14.3%, moderate effusion was present in 39.3%, and marked effusion was present in 46.4%. A significant relationship was observed between ADD and joint effusion (Table 1) ($p < 0.05$).

3.2. The correlation between joint effusion and VAS score

The mean VAS scores, based on joint effusion status and the results of the one-way ANOVA were calculated to determine whether the differences between these means were statistically significant. The mean VAS score in patients without effusion was 2.27, 2.55 in patients with moderate effusion, and 5.15 in patients with marked effusion. A significant correlation was observed between joint effusion status and the mean VAS scores ($p < 0.05$): the mean VAS score of patients with marked effusion was higher than those of patients without effusion or patients with moderate effusion. No significant association was observed between joints without effusion and joints with moderate effusion (Fig. 3) ($p > 0.05$).

3.3. The correlation between ADD and VAS

The mean VAS score of joints without ADD was 0, 2.92 for joints with ADDWR, and 4.36 for joints with ADDWOR (Fig. 4). There was a significant correlation between ADD status and mean VAS score ($p < 0.05$): the mean VAS score of patients with ADDWOR was higher than that of patients with ADDWR, and both of these were higher than the mean VAS score of patients without ADD.

4. Discussion

Histopathologically, the synovial effusion is the excessive accumulation of mucin over joints. This may result from

Table 1
Relationship between joint effusion and ADD.

Joint Effusion & ADD			ADD			Total
			No ADD	ADDWR	ADDWOR	
Joint effusion	No effusion	n	3	51	12	66
		%	50.0%	34.0%	14.3%	27.5%
	Moderate effusion	n	0	60	33	93
		%	0.0%	40.0%	39.3%	38.8%
	Marked effusion	n	3	39	39	81
		%	50.0%	26.0%	46.4%	33.8%
Total		n	6	150	84	240
		%	100.0%	100.0%	100.0%	100.0%

Chi-square = 0.001

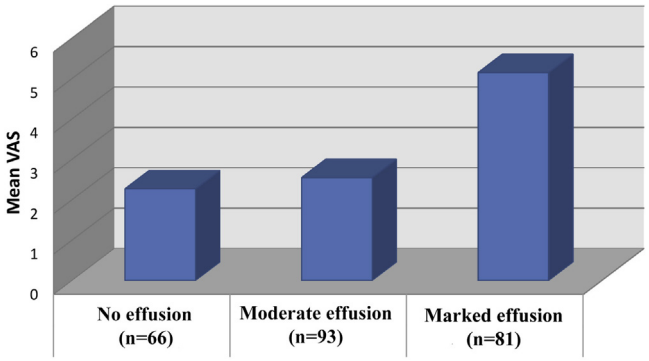

Fig. 3. The relationship between joint effusion and VAS.

mechanical or physical causes, or it may occur in response to a variety of reactions in the inflammatory system. Traumatic effusion is a consequence of cell damage caused by mechanical injury of the structures that form the joint; inflammatory effusion is caused by the phagocytic attack of phagocytic cells, predominantly neutrophils, as a result of an autoimmune reaction, such as arthritis, to the presence of a synovial protein-like structure in the joint, resulting in the formation of free radicals, which destroy joint-forming structures (Kapitonova and Othman, 2004). Biochemical analysis of the synovial fluid that causes effusion has shown it to consist of various components (Kubota et al., 1998; Takahashi et al., 1999; Güler et al., 2003; Ohkubo et al., 2009). Several studies have reported that changes in the synovial membrane are mediated by matrix metalloprotease activation or collagenase release from the fibroblasts and chondrocytes in tissues (Takahashi et al., 1999; Güler et al., 2003). However, another study showed no correlation among pain level, TMD, and total protein concentration in the synovial fluid (Segami et al., 2002).

There have been several studies aimed at evaluating joint effusion, the presence of ID, pain, and dysfunction (Westesson and Brooks, 1992; Murakami et al., 1996; Yano et al., 2004). Önder et al. (2010) reported that there was only a pain-related correlation between clinical signs and symptoms and joint effusion observed on TMJ MRI scans. Moreover, they found a significant correlation between joint effusion and ADDWOR. While some studies have detected high rates of effusion in painful joints others detected no such association (Sano and Westesson, 1995; Murakami et al., 1996; Yano et al., 2004; Khawaja et al., 2017). Although several studies have investigated the association between increased intracapsular fluid content and pain, none have yielded significant results (Westesson and Brooks, 1992; Kubota et al., 1998). Sano and Westesson (1995) used MRI to compare the

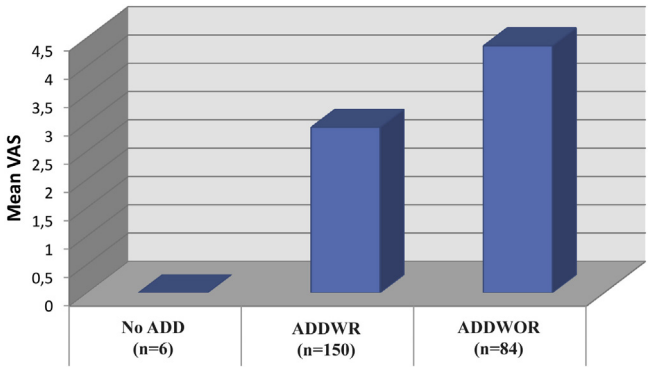

Fig. 4. The relationship between ADD and VAS.

signal increase in painful and painless joints and observed a higher signal increase in painful joints. The present study's findings also indicate a positive relationship between pain and joint effusion: similar to the Sano and Westesson (1995) study, this study's results show that the signal increase is greater in painful joints. Research has shown that small fluid accumulations may also be observed in asymptomatic patients (Sano and Westesson, 1995; Ohkubo et al., 2009). Similarly, the findings from this study of effusion in 75 asymptomatic joints suggest that there is no direct correlation between effusion and pain and that various aetiologies may be responsible.

Adame et al. (1998) reported that TMJ effusion was associated with disc displacement and degenerative changes (e.g., osteophytes, avascular necrosis, osteochondritis dissecans) and clicking was more frequently observed in TMJs without effusion. A Turkish population study of 100 cases revealed an association between ID type and changes in signal intensity (Şener and Akgünlü, 2004). Evaluation of ID type and joint effusion indicated that the association was strongest in joints with ADDWOR (Katzberg et al., 1988; Murakami et al., 1991; Westesson and Brooks, 1992; Takahashi et al., 1999; Sano et al., 2003; Ohkubo et al., 2009). The present study detected a correlation between the presence of ID and effusion, as detected using MRI. There was a significant difference between ADDWR and ADDWOR with regard to effusion. However, the absence of effusion in 51 joints with ADDWR and in 12 joints with ADDWOR suggests that effusion is not directly correlated with ADD.

The ability to verify the presence of excess fluid in articular spaces using MRI assists considerably with the diagnosis of articular diseases (Kubota et al., 1998). Even a small amount of fluid accumulation may indicate a pathological condition afflicting the TMJ (Manfredini et al., 2003). Scholarship has emphasised the elimination of intra-articular fluid in TMD as a major treatment goal (Sano and Westesson, 1995; Larheirn, 1995; Hosgor et al., 2017). Additionally, the ability to determine the frequencies at which TMJ effusion and ADD occur in asymptomatic individuals is also crucial in understanding the causes of TMJ dysfunction and in developing appropriate diagnosis and treatment strategies. In this study, the pain was observed to increase in response to increased accumulation of effusion. It was found that while there was no significant difference in pain in joints with non-effusion and moderate effusion, the pain was significantly increased in joints with marked effusion. Additionally, with regard to the presence of disc displacement, the pain was most commonly observed in association with ADDWOR and less pain was observed in association with ADDWR. Consequently, effusion was observed to increase in direct proportion to pain severity and disc displacement. From a clinical perspective, the elimination of intra-articular fluid in association with effusion, as observed in MRI scans, and accompanying pain symptoms should be considered. It should also be borne in mind, however, that not all asymptomatic effusion cases will necessarily require treatment. Clinicians should determine the appropriate treatment based on a joint analysis of the patient's clinical and radiological examination data. Asymptomatic joints in which effusion has been detected should be followed up, bearing in mind that they may be candidates for intracapsular disorders.

5. Conclusion

In conclusion, TMJ effusion is associated with both ADD and joint pain. Effusion increased in direct proportion to the severity of pain and disc displacement. It should also be considered that various aetiologies may be responsible.

Ethical approval

The study was approved by the Clinical Research Ethics Committee of the Kocaeli University (KÜ GOKAEK 2018/78).

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None.

Conflicts of interest

There is no conflict of interest with regard to this paper.

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