Int. J. Oral Maxillofac. Surg. 2026; 55: 700–706
https://doi.org/10.1016/j.ijom.2026.01.015, available online at https://www.sciencedirect.com

International Journal of Oral & Maxillofacial Surgery

Clinical Paper

TMJ

Timing of arthrocentesis and its association with treatment success in painful temporomandibular joint disorders: a two-decade cohort study

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Y. H. Tang, N. van Bakelen, B. Gareb, F. Spijkervet: Timing of arthrocentesis and its association with treatment success in painful temporomandibular joint disorders: a two-decade cohort study. Int. J. Oral Maxillofac. Surg. 2026; 55: 700–706. © 2026 The Authors. Published by Elsevier Inc. on behalf of International Association of Oral and Maxillofacial Surgeons. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

Abstract. Arthrocentesis is commonly employed for symptomatic temporomandibular joint (TMJ) disorders when conservative treatments are unsuccessful. To date, the optimal timing for initiating arthrocentesis remains unclear. This retrospective cohort study, undertaken at a tertiary centre over two decades, aimed to evaluate the association between symptom duration and treatment success of initial arthrocentesis. Adults with painful TMJ disorders were included. The exclusion criteria were prior TMJ surgery, systemic rheumatic or connective tissue diseases, bony ankylosis, dentofacial deformities or significant TMJ trauma. The primary study outcome was patient-reported treatment success over 5 years. Generalized estimating equation (GEE) models were performed to evaluate the association between symptom duration and treatment success, and included the prognostic factors age, gender, diagnosis, preoperative conservative treatments, and adjuvant therapy during arthrocentesis. A total of 438 subjects were included in the study. GEE models indicated that a longer symptom duration was significantly associated with lower odds of patient-reported treatment success over a follow-up period of 5 years (odds ratio 0.974 per month, 95% confidence interval 0.966–0.983; $P < 0.001$). Within its limitations, this study indicates that performing arthrocentesis at an earlier stage may increase the likelihood of reaching adequate symptom reduction in the management of painful TMJ disorders.

Keywords: Osteoarthritis; Minimally invasive surgical procedures; Craniomandibular disorders; Jaw; Temporomandibular joint disc.

Accepted for publication 15 January 2026
Available online 29 January 2026

0901-5027/550700 + 7

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Temporomandibular joint (TMJ) disorders are a group of disorders that affect approximately one-third of the general population[1]. Management strategies for symptomatic cases typically follow a stepwise approach based on treatment response. First-line treatment often involves conservative interventions such as splint application, physiotherapy and pharmacological therapy. Minimally invasive surgical procedures, such as arthrocentesis, are effective treatment modalities and are often only performed if conservative treatments fail to achieve adequate symptom relief[2].

A major challenge in current clinical practice is determining the optimal timing for transitioning to subsequent treatments when initial interventions have failed. The absence of a consensus on defining treatment failure and timing for treatment escalation often leads to variability in clinical decision-making. As such, some patients undergo prolonged conservative treatments without any significant symptom resolution. Understanding the timely use of subsequent, more-invasive treatments is critical, as prolonged ineffective treatments may contribute to chronic disease progression, which may lead to resistance to future treatments[3]. Thus, identifying the ideal timing for initial arthrocentesis could aid clinicians in the decision-making process within the stepwise treatment framework for TMJ disorders following unsuccessful conservative treatment.

Currently, evidence regarding the optimal timing of arthrocentesis remains scarce. Some evidence suggests that performing arthrocentesis at an earlier stage may be beneficial[4,5]. A recent systematic review assessing the ideal timing of arthrocentesis concluded that early arthrocentesis (i.e. within 3 months of failing conservative treatment) may be more effective for symptom reduction compared with late arthrocentesis (i.e. after at least 3 months of conservative treatment).[6] However, direct evidence from studies examining the relationship between symptom duration and treatment success remains inconclusive[3,7].

This study aimed to assess whether the timing of initial arthrocentesis for painful TMJ disorders affects treatment outcomes. Specifically, the primary aim of this study was to evaluate the association between the duration of symptoms prior to initial arthrocentesis and the patient-reported success of the procedure over a 5-year follow-up period.

Methods

Study design

A retrospective cohort study was performed at University Medical Centre Groningen (UMCG), the Netherlands, which is a tertiary referral centre with expertise in TMJ surgery. A pre-specified protocol was finalized before the study commenced. Patient records of individuals who had undergone TMJ arthrocentesis at least 5 years previously were analysed retrospectively and consecutively, beginning with the most recent cases and progressing chronologically backwards.

Study population

All study subjects were treated at the outpatient clinic of the Department of Oral and Maxillofacial Surgery, UMCG. Subjects aged ≥18 years who underwent arthrocentesis under local anaesthesia, and who suffered from TMJ arthralgia, proven with a diagnostic intra-articular injection with articaine (4%) and epinephrine (1:100,000), were included in this study[8]. Subjects were excluded if they suffered from systemic rheumatic diseases; connective tissue diseases; bony ankylosis; congenital or acquired dentofacial deformities; or had a history of trauma that resulted in jaw or TMJ pain, bony changes or growth restriction. Furthermore, subjects were excluded if they had undergone surgical treatment of the same TMJ previously, or if the duration of symptoms or follow-up was not reported in their records.

Outcome measures

As standardized outcomes such as pain scores were not expected to be reported routinely in patient files, the primary study outcome was patient-reported success of primary arthrocentesis over time. This outcome was assessed at 1-year and 5-year follow-up. For this binary study outcome, patient-reported success was defined as the subjective feeling of adequate treatment effect, with no requirement for additional treatment. The secondary study outcomes were pain-related success [≥30%[9] or ≥12 mm[10] improvement on a visual analogue scale (VAS) 0–100 mm] assessed at 1 and 5 years, maximum mouth opening (MMO)-related success (≥6 mm[11] improvement in subjects with restricted mouth opening) assessed at 1 and 5 years, and combined pain- and MMO-related success (postoperative $\leq$30 mm VAS and $\geq$35 mm MMO). Furthermore, continuous secondary outcomes involved pain reduction (VAS) and MMO improvement assessed at 1 and 5 years. Finally, the number of retreatments in the follow-up period following initial arthrocentesis was registered.

Statistical analysis

Normality of continuous data was evaluated through visual examination of Q–Q plots and the Shapiro–Wilk test. Normally distributed data have been presented as mean and standard deviation (SD), while non-normally distributed variables have been presented as median and first and third quartiles (Q1–Q3).

In order to evaluate the association between symptom duration and repeated measurements of treatment success, GEE models were employed for the primary study outcome (patient-reported success). As the outcome variable was binary, a binomial distribution with a logit link function was fitted. GEE models were selected to account for repeated measures within subjects and the inclusion of time-dependent covariates. Predictors included in the GEE model were selected based on their potential prognostic relevance. These variables comprised the duration of symptoms before initial arthrocentesis (in months), duration of follow-up (in months), age, sex, previous conservative treatments (i.e. physiotherapy, splint and non-steroidal anti-inflammatory drugs), adjuvant therapy during arthrocentesis (i.e. corticosteroids and hyaluronic acid), and underlying diagnosis (i.e. disc displacement with reduction, disc displacement without reduction, and degenerative joint disease). As subjects could have more than one diagnosis, each diagnostic category was modelled as a separate binary predictor. An exchangeable correlation structure was applied in all models to account for intrasubject correlation. A secondary analysis was performed to further investigate the association between symptom duration and patient-reported success, using a dichotomized predictor of symptom duration instead

of the continuous variable. In this analysis, symptom duration was classified into timely (≤6 months) and delayed (>6 months) treatment. This approach enabled estimation of the relative odds of treatment success for both timely and delayed treatment. The threshold was selected based on the authors' clinical judgement. The concordance index (C-index) for each GEE model was calculated using predicted probabilities to assess its discriminatory capabilities. In order to assess whether diagnostic heterogeneity influenced the results, a sensitivity analysis was performed where the cohort was stratified into pre- and post-implementation periods of the diagnostic criteria for temporomandibular disorders (DC/TMD).[12] GEE models were then employed for each subgroup to assess the robustness of the associations between the diagnostic periods, and with the primary analysis.

All models yielded odds ratios (OR) with corresponding 95% confidence intervals (CI). GEE were performed in R version 4.5.0 (R Foundation for Statistical Computing, Vienna, Austria), using the geepack package.[13] Descriptive statistics and two-grouped comparison tests were performed in SPSS version 28 (IBM Corp., Armonk, NY, USA). A *P*-value ≤0.05 (two-tailed) was considered to indicate significance.

Results

In total, 691 patient files from March 2000 to March 2020 were analysed, and 438 subjects were included in this study. The primary reasons for exclusion were previous surgical treatment or trauma of the TMJ, a history of rheumatic disease or Ehlers–Danlos syndrome, age <18 years, and missing data regarding the duration of symptoms or follow-up. The median age (Q1–Q3) of study participants was 38.5 (24.0–54.0) years, 373 (85.2%) were female and 65 (14.8%) were male. The median (Q1–Q3) duration of symptoms was 13 (7.8–25.0) months. All baseline characteristics are displayed in Table 1.

Table 1. Baseline characteristics of study population.

Predictors	Baseline value	Total *n*
Male, *n* (%)	65 (14.8)	438
Age, years, median (Q1–Q3)	38.5 (24.0–54.0)	438
Duration of symptoms, months, median (Q1–Q3)	13 (7.8–25.0)	438
Duration of symptoms ≤6 months, *n* (%)	80 (18.3)	438
Pain 0–100 mm, median (Q1–Q3)	70.0 (50.0–80.0)	98
MMO, mm, mean (SD)	31.6 (8.9)	364
Diagnosis		
ADDwR, *n* (%)	111 (25.3)	438
ADDwoR, *n* (%)	167 (38.1)	438
DJD, *n* (%)	166 (37.9)	438
Preoperative conservative treatment		
Physiotherapy, *n* (%)	162 (37.0)	438
Splint, *n* (%)	106 (24.2)	438
NSAID, *n* (%)	251 (57.3)	438
Adjuvant therapy during arthrocentesis		
Corticosteroids, *n* (%)	321 (73.3)	438
Hyaluronic acid, *n* (%)	45 (10.3)	438

n, number of subjects; Q1–Q3, first quartile to third quartile; MMO, maximum mouth opening; SD, standard deviation; ADDwR, anterior disc displacement with reduction; ADDwoR, anterior disc displacement without reduction; DJD, degenerative joint disease; NSAID, non-steroidal anti-inflammatory drugs.

All (*n* = 438) patients reported treatment success. Patient-reported success was 70.3% at 1-year follow-up and 65.5% at 5-year follow-up. The pain-related success rate was 92.1% at 1-year follow-up (*n* = 63) and 92.3% at 5-year follow-up (*n* = 13). The mean (SD) reduction in pain-score was 51.0 (24.8) mm at 1-year follow-up (*n* = 63) and 58.1 (27.6) mm at 5-year follow-up (*n* = 13) using the VAS. The MMO-related success rate was 60.8% at 1-year follow-up (*n* = 176) and 59.1% at 5-year follow-up (*n* = 66). The mean (SD) improvement in MMO was 5.8 (8.3) mm at 1-year follow-up (*n* = 223) and 6.0 (9.3) mm at 5-year follow-up (*n* = 79). The combined pain- and MMO-related success rate was 59.0% at 1-year follow-up (*n* = 39) and 71.4% at 5-year follow-up (*n* = 28) (Table 2). In total, 136 subjects (31.1%) received additional treatment within 5 years of initial arthrocentesis.

GEE indicated that a longer symptom duration was significantly associated with a lower odds of patient-reported treatment success over a 5-year period (OR 0.974 per month, 95% CI 0.966–0.983; $P < 0.001$) (Table 3). The model showed good discriminative ability, with a C-index of 0.719. Furthermore, the use of adjuvant corticosteroids or hyaluronic acid was significantly associated with lower odds of patient-reported success. Age, gender, diagnosis and use of preoperative conservative treatments were not prognostic factors for success. Secondary GEE analysis indicated that subjects treated within 6 months of symptom onset had 2.7 times higher odds of treatment success than those treated later (OR 2.71, 95% CI 1.40–5.26; $P = 0.003$). The C-index was 0.676, indicating that the model had moderate discriminative ability.

Sensitivity analysis stratifying the cohort between pre- (*n* = 312) and post-implementation (*n* = 126) of the DC/TMD yielded results consistent with the primary GEE model (Supplemental file 1). Differences in diagnostic cohort did not influence the study results substantially, as associations were comparable across the stratified and primary models.

Discussion

This two-decade study aimed to evaluate the association between symptom duration prior to initial arthrocentesis and treatment success for painful TMJ disorders over a 5-year follow-up period in a cohort of 438 subjects, treated at a tertiary referral institution. The results demonstrate a significant negative association between symptom duration and patient-reported success (OR 0.974 per month, 95% CI 0.966–0.983; *P* 0.001). Specifically, each additional month of symptoms prior to initial arthrocentesis was associated with a 2.6% decrease in the odds of treatment success. Furthermore, initial arthrocentesis within 6 months of symptom onset improved the odds of treatment success drastically compared with treatment initiated after 6 months of symptoms (OR 2.71, 95% CI 1.40–5.26; $P = 0.003$). In other words, patients treated within 6 months of symptom onset had 2.7 times higher odds of experiencing success compared with those treated 6 months or more after symptom onset. These findings suggest that prolonged symptom

Table 2. Results of study outcomes at 1- and 5-year follow-up.

Outcome	1-year follow-up		5-year follow-up	
	Events (%)	*n*	Events (%)	*n*
Patient-reported success	308 (70.3)	438	287 (65.5)	438
Pain-related success[a]	58 (92.1)	63	12 (92.3)	13
MMO-related success[b]	107 (60.8)	176	39 (59.1)	66
Combined success[c]	23 (59.0)	39	20 (71.4)	28
	Mean (SD)	*n*	Mean (SD)	*n*
Pain reduction	51.0 (24.8)	63	58.1 (27.6)	13
MMO improvement	5.8 (8.3)	223	6.0 (9.3)	79

n, number of subjects; MMO, maximum mouth opening; SD, standard deviation.
[a]≥30% or ≥12 mm improvement on visual analogue scale (0–100).
[b]≥6 mm improvement in subjects with restricted mouth opening (only in subjects with restricted mouth opening).
[c]Postoperative ≤30 mm on visual analogue scale (0–100) and ≥35 mm MMO.

duration may diminish the likelihood of achieving satisfactory outcomes from arthrocentesis, highlighting the importance of timely referral and early initiation of arthrocentesis in patients with painful TMJ disorders.

The rationale for symptom reduction following arthrocentesis is currently hypothesized to be attributed to the washing out of pro-inflammatory cytokines, matrix-degrading enzymes and metabolic waste products from the joint,[14] which contributes to synovitis and, consequently, pain.[15] However, this mechanism does not explain the reduced efficacy of arthrocentesis observed in patients with prolonged symptom duration. The association between symptom duration and treatment outcome observed in this study may be attributed, in part, to the involvement of a distinct pathophysiological system in certain patients with chronic symptoms. For instance, in individuals with prolonged and intense pain, continuous activation of nociceptors may lead to peripheral sensitization, in which increased excitability of these nociceptors results in intensified pain responses.[16,17] This chronic pain may persist if the underlying pathology remains active. In some subjects, ongoing peripheral input may progress to central sensitization,[18,19] a condition in which persistent peripheral pain signals lead to changes in the central nervous system, resulting in lower pain thresholds and intensified pain responses, such as allodynia and hyperalgesia, even after removal of the stimulus.[16,17] In such cases, the central nervous system may be triggered by persistent inflammatory activity in the joint, but may maintain symptoms even when peripheral tissue damage is no longer present.[20] This mechanism could explain why some patients continue to experience symptoms despite the washing out of symptom-inducing products from the joint. Consequently, this group of patients may benefit from additional therapeutic modalities other than arthrocentesis, such as interventions based on a more centrally modulated approach.[17,19,20] Alternatively, persistent pain after arthrocentesis could also result from concomitant pain from the masticatory muscles,[21] a secondary reactive response to arthrogenous pain that does not resolve fully with joint-focused interventions.

In the present study, the primary GEE model indicated that predictors such as age, gender, diagnosis and preoperative conservative treatments did not influence patient-reported success significantly. The finding that age and gender are not prognostic factors for treatment success has been established in previous studies.[3,22] This may be due to a possible higher likelihood that treatment outcomes are driven by the underlying pathophysiology (e.g. inflammatory, mechanical and pain-processing factors) than demographic factors.

Although arthrocentesis has been shown to be effective for anterior disc displacement and degenerative joint disease, evidence suggests that it is most

Table 3. Results of generalized estimating equations on patient-reported success.

Predictor	OR	95% CI	*P*
Duration of symptoms, months	0.974	0.966–0.983	< 0.001
Follow-up duration, months	0.996	0.994–0.998	< 0.001
Age, years	0.999	0.984–1.010	0.884
Gender (reference = male)	0.624	0.313–1.250	0.181
Diagnosis			
ADDwR	1.020	0.542–1.930	0.942
ADDwoR	1.070	0.611–1.880	0.809
DJD	0.937	0.546–1.610	0.815
Preoperative conservative treatment			
Physiotherapy	0.762	0.463–1.250	0.286
Splint	0.852	0.478–1.420	0.489
NSAID	0.865	0.526–1.420	0.568
Adjuvant therapy during arthrocentesis			
Corticosteroids	0.389	0.209–0.723	0.003
Hyaluronic acid	0.358	0.153–0.835	0.018

OR, odds ratio; CI, confidence interval; ADDwR, anterior disc displacement with reduction; ADDwoR, anterior disc displacement without reduction; DJD, degenerative joint disease; NSAID, non-steroidal anti-inflammatory drugs.

effective for symptomatic anterior disc displacement without reduction.[23,24] In the present study, co-occurrence of the underlying diagnosis with arthralgia did not impact patient-reported success significantly. Sensitivity analyses yielded similar results as the primary analysis, indicating that the discrepancy from previous reports is less likely to be explained by diagnostic heterogeneity, but rather by underlying factors not explored in the present study. Furthermore, previous conservative treatment (e.g. physiotherapy, splint and/or non-steroidal anti-inflammatory drugs) was not associated with improved patient-reported success. This may be due to the fact that patients who proceed to arthrocentesis represent a more treatment-resistant subgroup in whom conservative options have already failed, minimizing their predictive value for postoperative success. Additionally, such conservative treatments may not target intra-articular pathologies, such as adhesion formation, as effectively as arthrocentesis. In the GEE model, the use of adjuvant hyaluronic acid or corticosteroids during arthrocentesis was associated with lower odds of patient-reported success. Although the effectiveness of these adjuvant therapies remains debated at least,[25,26] current evidence does not suggest that they worsen outcomes. Therefore, the current finding is likely attributable to confounding by indication, where subjects with more severe symptoms were more likely to receive adjuvant treatment. The observed association between the use of adjuvant treatment and lower treatment success is thus more likely to reflect the use of these therapies in patients with more severe symptoms, rather than a detrimental effect of these therapies themselves.

Within the limitations of the substantial amount of missing data for the secondary success criteria (i.e. pain scores and MMO), patient-reported success appeared to show similar rates of improvement as success based on MMO. In contrast, pain-related success was higher than patient-reported success, potentially indicating that a reduction of 12 mm on the VAS or a 30% decrease in pain intensity may not be sufficient for patients to perceive the treatment as successful. When considering continuous outcomes, joint pain demonstrated an improvement over time, with a mean (SD) reduction of 51.0 (24.8) mm at 1-year follow-up and 58.1 (27.6) mm at 5-year follow-up using the VAS. These findings are consistent with the current evidence,[5,27] supporting the notion that arthrocentesis is primarily effective in alleviating joint pain, while contributing only modestly to improvements in MMO. Nonetheless, the substantial proportion of missing data for pain scores and MMO improvement introduces a risk of attrition bias. As these outcomes were only reported for a proportion of the subjects, the observed results may represent a disproportionate reflection of the outcomes of subjects with a specific level of disease severity. This may limit the internal validity and generalizability of the findings. As such, these secondary results should be interpreted with caution and regarded as exploratory.

This study has several limitations. The retrospective design limited the ability to control for confounding variables, and may have introduced selection and attrition bias inherent to this study design. Furthermore, the study population was treated at a tertiary referral centre, potentially limiting the generalizability to a broader population. Strengths of this study include its long-term follow-up, providing insights into the sustained effects of arthrocentesis over time. Additionally, using patient-reported success as the primary outcome represents a significant strength, as it involves the patient's perspective and represents an individualized, patient-centred measure. However, it is not based on a quantitative metric and is inherently subjective, potentially influenced by factors such as individual expectations or satisfaction. Previous studies focused on quantifiable success criteria such as pain reduction and MMO improvement, but these neglect the ultimate aim of treatment: patient-reported success.

This retrospective study may serve as a hypothesis-generating study for future prospective research. Future studies, ideally prospective cohort studies or randomized controlled trials, should aim to standardize the use of a comprehensive set of outcome measures based on both the pre- and post-operative change scores. Establishing uniform and clear definitions of treatment success is crucial to enable meaningful comparisons across studies, and improve the interpretation of study results. Importantly, upcoming studies should not be limited to outcomes such as pain and MMO, but should also incorporate validated, quantifiable patient-reported outcomes, such as the validated Mandibular Function Impairment Questionnaire.[28] Only through standardized and comprehensive evaluation in well-designed prospective studies can definitive conclusions be drawn regarding the relationship between symptom duration and treatment success.

In conclusion, this study indicates that a longer symptom duration is negatively associated with patient-reported success of initial arthrocentesis as therapy for painful TMJ disorders. Each additional month of symptoms prior to initial arthrocentesis is associated with a 2.6% decrease in the odds of treatment success, and patients treated within 6 months of symptom onset have 2.7 times higher odds of experiencing success compared with those treated 6 months or more after symptom onset. Within the limitations of the study, the results indicate that performing arthrocentesis at an earlier stage may increase the likelihood of arthrocentesis achieving adequate symptom reduction.

Ethical approval

Ethical approval was given by the central ethics review board of the University Medical Centre Groningen, the Netherlands (Research Registration No. 20477).

Patient consent

An exemption was given by the Central Ethics Review Board of the University Medical Centre Groningen regarding the need for patient consent.

Funding

None.

Competing interests

None.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ijom.2026.01.015.

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