Minimally Invasive Surgeries for Treatment of Temporomandibular Disorders: Prognostic Indicators and Persistence of Treatment Outcome over a 5-year Follow-up Study

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Research Article

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Abstract

Patients refractory to conservative treatment of temporomandibular disorders (TMD) are candidates for more invasive treatments like arthroscopy and arthrocentesis. The aim of the present study was to identify predictors of long-term success and persistence of treatment outcome for temporomandibular joint (TMJ) arthroscopic lysis and lavage and arthrocentesis for treatment of TMD. Analysis of 64 minimally invasive surgeries used to treat disc displacement without reduction in group I (n = 36), and osteoarthritis in group II (n = 28) was conducted. Success was identified as a pain score ≤ 3, disability score ≤ 2 and maximal mouth opening greater than 35 mm. The overall success rate was 85.9%. Difference in success rate between groups was not significant ($p = 0.441$). Preoperative predictors of success in group I were fewer tender muscles ($p < 0.01$), shorter duration of symptoms ($p = 0.046$), lower pain ($p < 0.01$) and lower disability ($p = 0.0104$), while in group II were fewer tender muscles ($p < 0.01$), less limitation in opening ($p < 0.01$) and lower disability ($p = 0.0131$). In conclusion, arthroscopy and arthrocentesis were equally efficient after 5 years. Fewer tender muscles and lower disability preoperatively were common predictors of success. Pain recorded at one year, and maximum opening and disability recorded at 3 months were maintained after 5 years.

Introduction

Temporomandibular disorders are common and entangled group of disorders affecting the soft tissue and bony components of the temporomandibular joint (TMJ). Internal derangement of the TMJ is an abnormal functional and positional relationship of the articular components of the joint [1]. Among patients with TMD, 80% were reported to have internal derangement, which is usually divided into two main classes; disc displacement with reduction and disc displacement without reduction. Pain, joint sounds and limitation of mouth opening are the predominant symptoms, and are often disabling if the condition is left untreated [2]. Osteoarthritis of the TMJ often occurs in conjunction, or as a sequela of internal derangement, and involves degenerative changes in the soft tissue and bony components of the joint [3].

One of the commonly used classifications for TMD is the research diagnostic criteria for temporomandibular disorders (RDC/TMD), which has two assessment components; Axis I involves a clinical evaluation of signs and symptoms, while Axis II is an assessment of the psychosocial dysfunction and pain related disability [4,5]. Another popular classification is that proposed by Wilkes, which classifies TMD into five stages according to the severity of the clinical and radiologic findings [6].

The main objective in managing TMD is to reduce pain and restore normal function. Conservative treatment has been recommended as the starting point in the management process. This includes jaw rest, soft diet, non-steroidal anti-inflammatory drugs, physiotherapy and the use of different types of occlusal splints. Reports about success rates of different forms of non-surgical treatment have been contradicting, ranging from 36% [7] to 88% [8]. Patients refractory to conservative treatments are usually candidates for more invasive forms of treatment.

Open joint surgery was the principal treatment approach for patients not responding to conservative treatment in the past. Nowadays, open joint surgeries are indicated only after minimally invasive approaches fail. Procedures like synovectomy, discectomy, eminoplasty, eminectomy and disc plication are used to treat internal derangement and arthritis and are successful in reducing pain and increasing the range of mouth opening, but the associated risk is high [9,10]. Patients who do not improve after conservative treatment, minimally invasive and open joint surgeries are indicated for TMJ replacement. Currently, the minimally invasive approaches, like arthroscopy and arthrocentesis, are the treatment modalities of choice for managing TMD. The use of the arthroscope in the TMJ was first described by Onishi in 1975 [11]. Since then, a lot of progress has been achieved with respect to the use of arthroscopy in managing TMD [12-19]. Arthroscopic lysis and lavage has proven to be efficient in treating osteoarthritis and internal derangement of the TMJ by breaking the adhesions inside the joint, washing out the inflammatory mediators and eliminating the suction effect of the disk to the fossa [15]. Operative or advanced arthroscopy is another technique which uses instrumentation to perform procedures other than the lysis and lavage as debridement, miotomy, disc reduction and disc fixation [20]. In 1987, Murakami et al. introduced arthrocentesis of the TMJ [21]. They applied the same concept of lysis and lavage of the joint without the need for visualization. The double puncture arthrocentesis technique as used today was first described by Nitzan et al. in 1991 [22], while later several proposals for single puncture arthrocentesis were introduced [23-25].

The choice of either the arthroscopic lysis and lavage or arthrocentesis technique for treatment of TMD after failure of the conservative treatment is controversial, especially when both techniques share the same mode of action, and the indications for both techniques are overlapping [20]. The choice will depend on several factors, including the cost, available resources and the surgeon's experience. Each technique has its own advantages and disadvantages. Several studies have compared arthrocentesis and arthroscopic lavage of the TMJ for treatment of TMD [26-33], however the follow up periods in many of these studies were relatively short and the results were indecisive. The aim of this study was to identify the predictors of success and the persistence of treatment outcome for arthroscopic lysis and lavage and arthrocentesis with viscosupplementation for the treatment of temporomandibular disorders.

Materials And Methods

The clinical records of patients who had undergone TMJ arthroscopic lysis and lavage and arthrocentesis by one of the authors from January 2012 to August 2014 were retrieved and individually analyzed for inclusion in this study. Inclusion criteria included: 1) a unilateral diagnosis of disc displacement without reduction with limited opening (RDC/TMD group IIb) or osteoarthritis (RDC/TMD group IIIb) which was confirmed by MRI or CBCT or both, 2) failure to respond to conservative treatment after 2 months, 3) limited maximal mouth opening (MMO) <35mm, 4) joint noise and 5) pain score of 6 or more on a 10-point visual analog scale (VAS). Patients were excluded if they had incomplete medical records or if they had a history of TMJ surgery or a history of malignancy. The study was conducted at the department of Oral and Maxillofacial Surgery, College of Dentistry, Suez Canal University, Egypt, and

was approved ethically by the Research Ethics Committee at Suez Canal University (reference no. 2017/45). The study was conducted in accordance with the principles of the World Medical Association Declaration of Helsinki (version 2002). All patients signed an informed consent which was approved by the Research Ethics Committee. Informed consents to publish images in an online open-access publication were also obtained from the concerned patients.

Standardized questionnaires adopted from RDC/TMD[4] were used preoperatively and on each postoperative evaluation session to assess the TMJ pain and level of disability. Pain was assessed on a 10-point VAS with 0 indicating no pain, and 10 indicating the worst pain, while the disability level was measured on a disability scale graded by points according to the RDC/TMD Axis II, where no disability = 0 points, mild disability = 1 to 2 points, moderate disability = 3 to 4 points and severe disability = 5 to 6 points. The preoperative and postoperative clinical examinations were done by palpating all the masticatory and cervical muscles to identify areas of tenderness or sustained contractions. The MMO was measured as the interincisal distance between the upper and lower incisors while lateral excursions were measured as the distance between the maxillary and mandibular midlines on moving the mandible to the right and to the left. Joint sounds were auscultated during jaw motion and identified as clicking (short duration sound) or crepitus (long duration sound). The pattern of opening was observed for deviation. The history and duration of symptoms were recorded. Patients were then referred for radiologic assessment using MRI with or without CBCT.

Following clinical and radiographic examination, patients who were diagnosed with either disc displacement without reduction with limited opening (RDC/TMD group IIb) or osteoarthritis (RDC/TMD group IIIb) were referred for conservative treatment. The conservative treatment was carried out for 2 months and included jaw rest, soft diet, non-steroidal anti-inflammatory drugs, physiotherapy and soft stabilizing occlusal splint. Patients who did not respond to conservative treatment and accordingly had undergone minimally invasive surgeries (n=64; 43 females, 21 males; age range 18 to 52 years, mean 36.5 ± 9.6) were divided into 2 diagnostic groups; group I consisted of 36 patients (23 female, 13 male; age range 18 to 52 years, mean 37.56 ± 11.11) with disc displacement without reduction with limited opening, while group II consisted of 28 patients (20 female, 8 male; age range 21 to 52 years, mean 35.14 ± 7.18) with Osteoarthritis. Group I was subdivided into 2 groups; group Ia consisted of 18 patients (13 female, 5 male) who underwent arthroscopic lysis and lavage of the affected joints (Figure 1a) and group Ib consisted of 18 patients (10 female, 8 male) who underwent single-puncture arthrocentesis of the affected joints (Figure 1b). Group II was subdivided into 2 groups; group IIa consisted of 14 patients (11 female, 3 male) who underwent arthroscopic lysis and lavage and group IIb consisted of 14 patients (9 female, 5 male) who underwent single-puncture arthrocentesis of the affected joints.

Arthroscopic lysis and lavage was performed under general anesthesia using a 2.3 mm 30 degree arthroscope with a cannula of 2.4 mm internal diamter (Stryker Co., San Jose, CA, USA). The trocar and cannula were inserted at a point 10 mm in front of the tragus, and 2 mm below the canthal-tragus line in cases where the canthal-tragus distance was ≥70 mm. In cases where the canthal-tragus distance was <70 mm, the location for insertion was marked as 7 mm in front of the tragus and 2 mm below the

canthal-tragus distance [34]. Lavage of the upper joint compartment was done using 300 ml normal saline. The trocar was moved in a gliding action from the anterior recess to the posterior recess to break the adhesions. Following the procedure, 1 ml of commercially available sodium hyaluronate was injected for viscosupplementation. Single-puncture arthrocentesis was performed under local anesthetic in an out-patient setting. The procedure involved the insertion of a Y-shaped dual-port cannula (Shepard cannula, Normed, Tuttlingen, Germany) into the upper joint compartment. The point of insertion was identical to that of the arthroscopy procedure. The position of the cannula inside the upper joint compartment was confirmed by its movement while opening and closing the mouth. The joint was irrigated by 300 ml of normal saline. Viscosupplementation then followed by injection of 1 ml commercially available sodium hyaluronate.

The postoperative care for all patients in both groups involved the prescription of nonsteroidal anti-inflammatory drugs for 3 days following surgery. All patients completed a standardized exercise protocol which started 1 day after surgery and lasted for 4 weeks. In patients with muscle spasms, a soft stabilizing occlusal splint was used immediately after surgery for 6 months. All patients were scheduled for evaluation on postoperative day 1, and 3 and 6 months, and 1, 3 and 5 years later. The outcome parameters recorded on the postoperative visits were subjective pain evaluation on a 10-point VAS, the maximal mouth opening measured as the interincisal distance between the upper and lower incisors, the subjective level of disability indicated on a scale from 0 to 6 points, joint sounds and postoperative complications.

The treatment outcome was evaluated at the 5-year follow-up session and was categorized as either success or failure. Success was identified as a pain VAS score equal to or less than 3, disability score equal to or less than 2 and maximal mouth opening more than 35 mm. Failure was identified as incapacity to achieve one or more of the scores required for success. The recorded variables which were analyzed to assess their relation to the treatment outcome were the gender, age, preoperative duration of symptoms, preoperative muscular involvement, preoperative pain VAS, preoperative maximal mouth opening and disability scores.

Statistical analysis:

Quantitative variables were described by the mean and standard deviation and the upper and lower limits of the 95% confidence interval of the mean. Paired sample t test was used for testing measurements within the same group while independent sample t test was used for comparing the mean changes between groups. Chi-squared test and Fisher exact test were used for categorical data. General Linear Model (GLM) repeated measure ANOVA, with time as within subjects factor and group as the between subjects factor, was used for the analysis of change in treatment outcome variables with time. Due to the significant Mauchly's Test of Sphericity results, Greenhouse-Geisser correction was applied. Bonferroni Method was applied for multiple comparisons. Significance level was set at $P < 0.05$. Statistical analysis was performed using SPSS (version 17).

Results

In total, 86 arthroscopic lysis and lavage and arthrocentesis operations met the criteria for inclusion in this study. Twenty two operations were excluded, mainly due to the presence of incomplete medical records. The clinical records of the remaining 64 patients (43 females, 21 males; age range 18 to 52 years, mean 36.5 ± 9.6) were retrieved and individually analyzed. The mean follow-up period was 5.4 years. The overall success rate according to the defined criteria for the entire patients' population was 85.9% (n=55). The difference in success rate between the 2 diagnostic groups (group I and group II) was not statistically significant (p = 0.441).

Preoperative demographic and clinical variables (gender, age, duration of symptoms, muscle tenderness, Wilkes stage):

The difference in success rate in relation to gender was not statistically significant in group I (p = 0.541), in group II (p = 0.447) or when considering the 2 diagnostic groups collectively (p = 0.971). The mean age of patients with successful outcome in group I was 37.38 ± 10.94, in group II was 35.09 ± 7.5 and in the entire patients' population was 36.42 ± 9.64. The mean age of patients with a failure outcome in group I was 39 ± 14.17, in group II was 35.4 ± 6.19 and in both groups together was 37 ± 9.9. The difference in success rate in relation to age was not statistically significant in group I (p = 0.787), in group II (p = 0.931) or when considering the 2 diagnostic groups collectively (p = 0.867).

The mean preoperative duration of symptoms in months for the entire patients' population was 16.61 ± 11.58, for group I was 15.44 ± 10.8 and for group II was 18.11 ± 12.55. Patients with successful outcome had significantly shorter preoperative duration of symptoms in group I (p = 0.046), and in the 2 diagnostic groups collectively (p < 0.01). However, the duration of symptoms could not be correlated with the treatment outcome in group II (p = 0.103) (Figure 2a). All patients with unsuccessful outcome had tenderness in one or more jaw muscles preoperatively. In failure outcome cases, 3 patients (33.3%) had 4 tender muscles, 2 patients (22.2%) had 3 tender muscles, 3 patients (33.3%) had 2 tender muscles and 1 patient (11.1%) had 1 tender muscle. Patients with successful outcome had significantly lower number of tender jaw muscles during the preoperative examination compared to patients with unsuccessful outcome (p < 0.01). In successful outcome cases, 36 patients (65.5%) had no tender muscles, 3 patients (5.5%) had 4 tender muscles, 3 patients (5.5%) had 3 tender muscles, 6 patients (10.9%) had 2 tender muscles and 7 patients (12.7%) had 1 tender muscle.

When classifying patients according to Wilkes stages [6], there was no statistical significant difference between the different stages in relation to the treatment outcome in both groups and in the entire patients' population (p > 0.05) (Table 1).

Treatment outcome variables (pain, maximal mouth opening, disability, complications):

- Pain:

Pain levels significantly decreased in the arthroscopic lysis and lavage group (group Ia + group IIa) (p < 0.001) and in the arthrocentesis group (group Ib + group IIb) (p < 0.001) (Table 2). There was no statistically significant difference in pain reduction between arthroscopic lysis and lavage and arthrocentesis at the 5-year follow-up session (p = 0.664). Patients with successful outcome had significantly lower pain level (1.20 ± 0.93) compared with the unsuccessful cases (4.33 ± 0.71) at the 5-year follow-up session (p < 0.001). In group I, patients with successful outcome had significantly lower preoperative pain level (7.25 ± 0.84) compared with the unsuccessful cases (8.50 ± 0.58) (p < 0.01). However, in group II, there was no statistically significant difference in preoperative pain level between successful (8.00 ± 0.90) and unsuccessful cases (8.60 ± 0.89) (p = 0.189).

- Maximal mouth opening:

MMO significantly increased in the arthroscopic lysis and lavage group (group Ia + group IIa) (p < 0.001) and in the arthrocentesis group (group Ib + group IIb) (p < 0.001) (Table 2). There was no statistically significant difference in MMO between arthroscopic lysis and lavage and arthrocentesis at the 5-year follow-up session (p = 0.068). Patients with successful outcome had significantly more increase in MMO (41.45 ± 2.72) compared with the unsuccessful cases (35.22 ± 3.60) at the 5-year follow-up session (p < 0.0001). In group I, there was no statistically significant difference in preoperative MMO between successful (29.53 ± 3.56) and unsuccessful cases (27.00 ± 1.41) (p = 0.173). However, in group II, patients with successful outcome had significantly larger preoperative MMO (27.53 ± 2.55) compared with patients with unsuccessful outcome (23.60 ± 3.36) (p < 0.01).

- Disability:

Disability scores significantly improved in the arthroscopic lysis and lavage group (group Ia + group IIa) (p < 0.001) and in the arthrocentesis group (group Ib + group IIb) (p < 0.001) (Table 3). There was no statistically significant difference in disability scores between arthroscopic lysis and lavage and arthrocentesis at the 5-year follow-up session (p = 0.636). Patients with successful outcome had significantly lower disability scores than those with unsuccessful outcome at the 5-year follow-up session (p < 0.001). At 5 years, patients with unsuccessful outcome had the most common disability scores as 3 (33%) and 2 (33%) followed by 4 (22.2%), then 1 (11.1%), whereas patients with successful outcome had the most common disability score as 0 (67.3%) followed by 1 (29.1%), then 2 (3.6%) then 3 (0.0%) and 4 (0.0%). Patients with successful outcome had significantly lower preoperative disability scores compared with patients with unsuccessful outcome in both group I (p=0.0104) and group II (p=0.0131).

- Complications:

One of 14 patients in group IIb had an intra-operative complication, in the form of a perforation of the external auditory canal. This patient recovered without any sequelae following the procedure and had no postoperative complications.

Analysis of change in treatment outcome variables with time:

- Pain:

The difference in pain VAS measured preoperatively was statistically significant compared to all other postoperative scores (3 months (p<0.001) and 6 months (p<0.001), 1 year (p<0.001), 3 years (p<0.001) and 5 years (p<0.001)). The difference in pain VAS measured at 3 months was statistically significant compared to that measured at 3 years (p=0.017) and that measured at 5 years (p<0.01). Pain measured at 6 months was statistically significant only when compared to that measured at 5 years (p=0.036) (Table 4). The change in pain VAS with time in group I and group II is shown in figure 2b.

Maximal mouth opening:

The difference in MMO measured preoperatively was statistically significant compared to all other postoperative scores (3 months (p<0.001) and 6 months (p<0.001), 1 year (p<0.001), 3 years (p<0.001) and 5 years (p<0.001) (Table 5). The change in MMO with time in group I and group II is shown in figure 2c.

Disability:

The difference in disability scores measured preoperatively was statistically significant compared to all other postoperative values (3 months (p<0.001) and 6 months (p<0.001), 1 year (p<0.001), 3 years (p<0.001) and 5 years (p<0.001) (Table 6). The change in disability scores with time in group I and group II is shown in figure 2d.

Discussion

Both arthroscopic lysis and lavage and arthrocentesis are regarded as efficient approaches for treating symptoms of TMD, with each technique having its own advantages and disadvantages. Arthroscopy helps in the diagnosis and treatment planning, and allows the blunt release of adhesions inside the joint, while arthrocentesis is more cost efficient, usually performed under local anesthesia as an in-office procedure, and allows the inflammatory mediators and debris to be flushed out of the joint for better prognosis [35]. It was suggested that both techniques differ in terms of complications, long term outcome and prognosis [30-32], although the conception behind both techniques is similar; which is the joint lavage [36]. Relapse of symptoms after initial successful treatment of TMD is a major problem, as it might lead to a more invasive form of treatment. It was suggested that the relapse of symptoms is common when TMJ inflammation is present [35], however, the predictors of long-term success of both arthrocentesis and arthroscopic lysis and lavage are missing in the literature. Investigating the effect of different preoperative variables on the outcome of minimally invasive TMJ surgeries is crucial, as it allows the surgeon to choose the correct treatment modality, and to better explain the prognosis to the patient.

In the present study, the overall success rate for the 2 diagnostic groups was 85.9%. This was in agreement to other studies which assessed the success rate of TMJ minimally invasive surgeries, and found that the symptoms settle in 70-86% of cases [37-39]. The results of the present study did not confirm

a relation between the age or gender of the patients and the treatment outcome, while it was suggested in a systematic review that older age might be considered a poor indicator for the prognosis of arthroscopy and arthrocentesis [40]. This was contradicted in another study which concluded that younger age is a predictor of a negative outcome for arthroscopic lysis and lavage [41]. The authors of the present study believe that more studies with large sample size are required to answer this question. With regards to the preoperative duration of symptoms, the results of the present study showed that the shorter duration of symptoms was a predictor of success for the treatment of disc displacement without reduction; however this relation could not be confirmed in cases of osteoarthritis although there was tendency towards the same result. This was in accordance to a systematic review suggesting that the chronicity of joint symptoms is a poor indicator for the outcome of both arthroscopy and arthrocentesis [40]. These findings raise concerns about a general attitude of TMD patients, who tend to ignore their symptoms for a long period of time before seeking treatment. It was reported that only one fifth of patients who exhibit symptoms will seek treatment, which negatively affects their prognosis [42].

One of the main findings of the present study is the confirmed relationship between the number of tender jaw muscles and the treatment outcome, where the lower number of tender jaw muscles during the preoperative clinical examination was significantly associated with a successful outcome. These results were in agreement with 2 other studies which found a positive correlation between the preoperative bilateral involvement of masticatory muscles and the negative surgical outcome [41,43]. The authors believe that controlling the muscular component, if present, is of prime importance for the success of both arthrocentesis and arthroscopy. This should be an objective of the conservative treatment which precedes the minimally invasive interventions. The management of the psychosocial component of TMD should also be considered during this period.

There was no influence of the Wilkes stages on the treatment outcome in the present study. This was in accordance to Gonzalez-Garcia and Rodriguez-Campo [44], who pointed out the importance of reporting data in terms of staging and time of evaluation, because of the changing course of TMD with time. In the present study, both arthroscopic lysis and lavage and arthrocentesis were equally efficient in reducing pain and improving MMO after 5 years. Several studies reported that both techniques are equally efficient in reducing pain, but arthroscopy was more efficient in improving MMO after 12 months [28,45].Another meta-analysis favoured arthroscopy with regards to both pain and MMO [40], while several studies found no differences between both techniques in reducing pain and increasing MMO, in agreement to the present study [29-32]. Nitzan argued that the success of minimally invasive surgeries in reducing pain and improving MMO is attributed to the effect of joint lavage, being efficient in releasing the joint adhesions, washing the inflammatory mediators and widening the narrowed joint space [36]. The authors of the present study believe that the success of both procedures is also closely related to the use of sufficient lavage volume and postoperative viscosupplementation, both of which are crucial for achieving and maintaining the favorable outcomes by preserving the TMJ's homeostasis.

In patients with disc displacement without reduction (group I), a lower preoperative pain level was a predictor of a successful outcome. However, in osteoarthritis cases (group II), there was no correlation between the preoperative pain level and the treatment outcome. It was previously reported by O'Connor RC et al. [35] that TMJ inflammation is an indicator for future relapse of symptoms, and thus an unsuccessful treatment outcome. In osteoarthritis, where inflammation and severe pain are common findings, other factors rather than the preoperative pain level might be influential in predicting the treatment outcome. In patients with osteoarthritis, the preoperative limitation in MMO seemed to correlate with the treatment outcome; however this correlation was not significant in patients with disc displacement without reduction. This was in full agreement with Ulmner M. et al. [41], who interpreted this finding by elaborating the intimate relation between the degree of inflammation inside the joint (as in cases of osteoarthritis) and the degree of limitation of MMO.

Self-graded disability scores improved significantly in both diagnostic groups. There was no statistically significant difference between arthroscopic lysis and lavage and arthrocentesis in improving disability at the end of the follow up period. Preoperative disability scores correlated positively with the treatment outcome in both arthroscopic lysis and lavage and arthrocentesis, as well as in both diagnostic groups. Thus disability can be recognized as a predictor for the treatment outcome. Like any surgical procedure, arthroscopy and arthrocentesis are not risk-free. However, the incidence of postoperative complications for both procedures is very low [22,46]. An overall complication rate of 1.34% has been reported [47]. In the present study, one patient in group IIb had a perforation of the external auditory canal, however, there were no sequelae following the procedure and the patient had no postoperative complications. The authors noticed a high incidence of transient facial nerve paralysis caused by auriculotemporal nerve block in arthrocentesis procedures. This was resolved spontaneously within 2 hours in all patients and thus was not considered a complication.

The analysis of change in treatment outcome variables with time has shown that the pain VAS recorded at the one-year follow-up session was maintained till the 5-year follow-up session. With regards to both MMO and disability, the values recorded at the 3-month follow-up session were maintained till the 5-year follow-up session.

The main limitations of this study were the retrospective design, the lack of control group and the small sample size. Therefore, the presented data should be interpreted with caution. However, considering the high prevalence of TMD [48], the findings of this study might encourage the pursuing of future studies with larger sample sizes and prospective design.

In conclusion, the overall success rate of minimally invasive surgeries for treating disc displacement without reduction and osteoarthritis in the present investigation was 85.9%. Both arthroscopic lysis and lavage and arthrocentesis were equally efficient in reducing pain, improving disability and MMO after 5 years. The results of the present study did not confirm a relation between the age, gender, Wilkes stage and the treatment outcome. In patients with disc displacement without reduction, the lower number of tender jaw muscles preoperatively, the shorter preoperative duration of symptoms, lower preoperative

pain levels and disability scores were predictors of a successful outcome. However, in osteoarthritis, the lower number of tender jaw muscles preoperatively, the less preoperative limitation in MMO and lower disability scores were predictors of a successful outcome. The pain VAS recorded at the one-year follow-up session was maintained till the 5-year follow-up session, while the values of MMO and disability recorded at the 3-month follow-up session were maintained till the 5-year follow-up session. These results might be valuable for surgeons to estimate the prognosis of TMD minimally invasive surgeries, and communicate their expectations with patients. Future studies with larger sample sizes and prospective design are needed to confirm the results of this investigation.

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Declarations

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Author contributions statement

Study conception and design: W.T.; data collection: W.T., Z.H., M.G.; analysis and interpretation of results: W.T., Z.H., M.G.; draft manuscript preparation: W.T., Z.H., M.G. All authors reviewed the results and approved the final version of the manuscript.

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Tables

Table 1: Relation between treatment outcome and Wilkes stage

	Wilkes stage	Treatment outcome			P Value
Entire patients' population		Failure	Success	Total	
	3	3	28	31	0.29082
		9.7%	90.3%	100.0%	
	4	1	11	12	
		8.3%	91.7%	100.0%	
	5	5	16	21	
		23.8%	76.2%	100.0%	
Total		9	55	64	
		14.1%	85.9%	100.0%	
Arthroscopy (group Ia + group IIa)	3	1	14	15	0.64192
		6.7%	93.3%	100.0%	
	4	1	5	6	
		16.7%	83.3%	100.0%	
	5	2	9	11	
		18.2%	81.8%	100.0%	
Total		4	28	32	
		12.5%	87.5%	100.0%	
Arthrocentesis (group Ib + group IIb)	3	2	14	16	0.24696
		12.5%	87.5%	100.0%	
	4	0	6	6	
		.0%	100.0%	100.0%	
	5	3	7	10	
		30.0%	70.0%	100.0%	
Total		5	27	32	
		15.6%	84.4%	100.0%	

Table 2: Pain VAS and MMO in arthroscopic lysis and lavage and arthrocentesis groups

Group		N	Mean	Std. Deviation	P value
Arthroscopy	P VAS Preop	32	7.75	1.11	0.000000*
	P VAS 5 years	32	1.63	1.39	
Arthrocentesis	P VAS preop	32	7.66	0.83	0.00000*
	P VAS 5 years	32	1.66	1.47	
Arthroscopy	MMO Preop	32	27.69	3.35	0.000000*
	MMO 5 years	32	40.91	3.50	
Arthrocentesis	MMO Preop	32	28.56	3.65	0.000000*
	MMO 5 years	32	40.25	3.66	

P, pain; VAS, visual analog scale; Preop, preoperative; MMO, maximal mouth opening; N, number; Std deviation, standard deviation; * Statistically significant ($p<0.05$)

Table 3: Disability scores in arthroscopic lysis and lavage and arthrocentesis groups

		Preoperative		5 Years		P Value
		Frequency	Percent	Frequency	Percent	
lity Score in Arthroscopy	0	0	0.0%	20	62.5%	0.00000*
	1	9	28.1%	8	25.0%	
	2	7	21.9%	2	6.3%	
	3	7	21.9%	2	6.3%	
	4	4	12.5%	0	0.0%	
	5	4	12.5%	0	0.0%	
	6	1	3.1%	0	0.0%	
lity Score in ɔcentesis	0	0	0.0%	17	53.1%	0.00000*
	1	8	25.0%	9	28.1%	
	2	8	25.0%	3	9.4%	
	3	8	25.0%	1	3.1%	
	4	3	9.4%	2	6.3%	
	5	4	12.5%	0	0.0%	
	6	1	3.1%	0	0.0%	

* Statistically significant ($p<0.05$)

Table 4: Analysis of change of pain VAS with time

		Mean Difference	Std. Error	95% Confidence Interval		P value
				Lower Bound	Upper Bound	
Preoperative	3 Months	5.26563	0.21	4.66	5.87	0.0000*
Preoperative	6 Months	5.43750	0.21	4.83	6.04	0.0000*
Preoperative	One Year	5.78125	0.21	5.18	6.39	0.0000*
Preoperative	3 Years	5.93750	0.21	5.33	6.54	0.0000*
Preoperative	5 Years	6.06250	0.21	5.46	6.67	0.0000*
3 Months	6 Months	0.17	0.21	-0.43	0.78	1.0000
3 Months	One Year	0.52	0.21	-0.09	1.12	0.1847
3 Months	3 Years	.67188	0.21	0.07	1.28	0.0172*
3 Months	5 Years	.79688	0.21	0.19	1.40	0.0018*
6 Months	One Year	0.34	0.21	-0.26	0.95	1.0000
6 Months	3 Years	0.50	0.21	-0.11	1.11	0.2279
6 Months	5 Years	.62500	0.21	0.02	1.23	0.0369*
One Year	3 Years	0.16	0.21	-0.45	0.76	1.0000
One Year	5 Years	0.28	0.21	-0.32	0.89	1.0000
3 Years	5 Years	0.13	0.21	-0.48	0.73	1.0000

VAS, visual analog scale; Std Error, standard error; * Statistically significant ($p<0.05$)

Table 5: Analysis of change of MMO with time

		Mean Difference	Std. Error	95% Confidence Interval		P value
				Lower Bound	Upper Bound	
perative	3 Months	-11.32813	0.62	-13.17	-9.48	0.0000*
perative	6 Months	-12.28125	0.62	-14.13	-10.44	0.0000*
perative	One Year	-12.50000	0.62	-14.34	-10.66	0.0000*
perative	3 Years	-12.50000	0.62	-14.34	-10.66	0.0000*
perative	5 Years	-12.45313	0.62	-14.30	-10.61	0.0000*
nths	6 Months	-0.95	0.62	-2.80	0.89	1.0000
nths	One Year	-1.17	0.62	-3.02	0.67	0.9197
nths	3 Years	-1.17	0.62	-3.02	0.67	0.9197
nths	5 Years	-1.13	0.62	-2.97	0.72	1.0000
nths	One Year	-0.22	0.62	-2.06	1.63	1.0000
nths	3 Years	-0.22	0.62	-2.06	1.63	1.0000
nths	5 Years	-0.17	0.62	-2.02	1.67	1.0000
Year	3 Years	0.00	0.62	-1.84	1.84	1.0000
Year	5 Years	0.05	0.62	-1.80	1.89	1.0000
ars	5 Years	0.05	0.62	-1.80	1.89	1.0000

MMO, maximal mouth opening; Std. Error, standard error; * Statistically significant ($p<0.05$)

Table 6: Analysis of change of disability scores with time

		Mean Difference	Std. Error	95% Confidence Interval		P value
				Lower Bound	Upper Bound	
perative	3 Months	1.85938	0.20	1.28	2.44	0.0000*
perative	6 Months	1.96875	0.20	1.39	2.55	0.0000*
perative	One Year	2.00000	0.20	1.42	2.58	0.0000*
perative	3 Years	1.96875	0.20	1.39	2.55	0.0000*
perative	5 Years	2.00000	0.20	1.42	2.58	0.0000*
nths	6 Months	0.11	0.20	-0.47	0.69	1.0000
nths	One Year	0.14	0.20	-0.44	0.72	1.0000
nths	3 Years	0.11	0.20	-0.47	0.69	1.0000
nths	5 Years	0.14	0.20	-0.44	0.72	1.0000
nths	One Year	0.03	0.20	-0.55	0.61	1.0000
nths	3 Years	0.00	0.20	-0.58	0.58	1.0000
nths	5 Years	0.03	0.20	-0.55	0.61	1.0000
Year	3 Years	-0.03	0.20	-0.61	0.55	1.0000
Year	5 Years	0.00	0.20	-0.58	0.58	1.0000
ırs	5 Years	0.03	0.20	-0.55	0.61	1.0000

Std. Error, standard error; * Statistically significant ($p<0.05$)

Figures

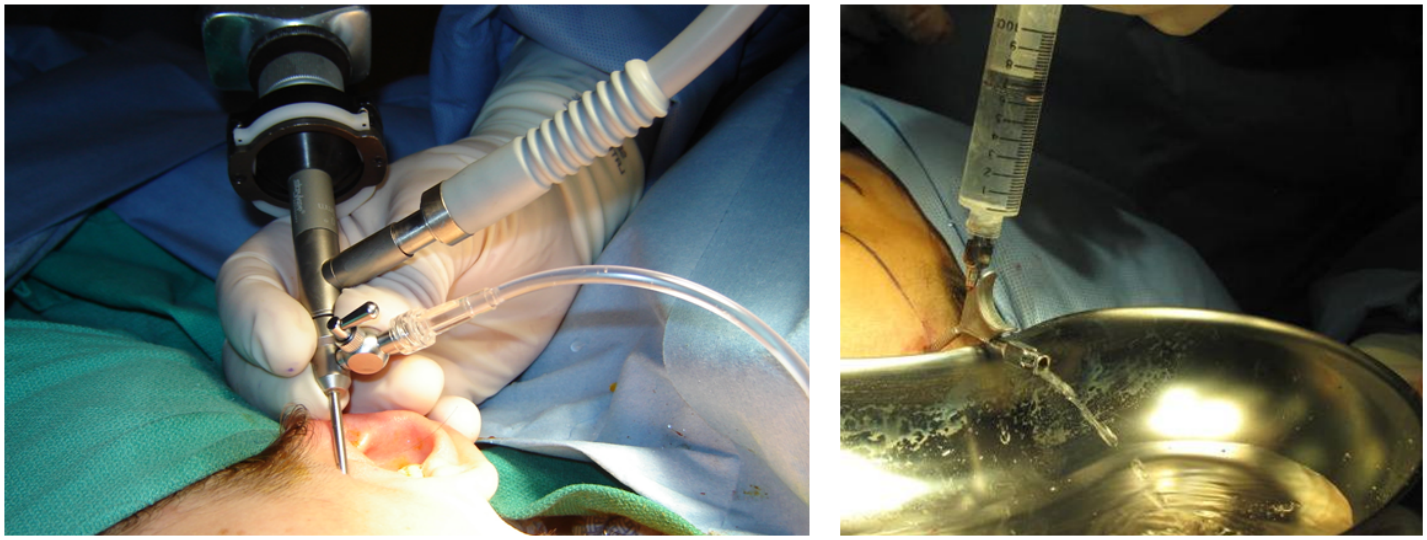

Figure 1

a) Arthroscopic lysis and lavage technique, b) Single-needle arthrocentesis technique

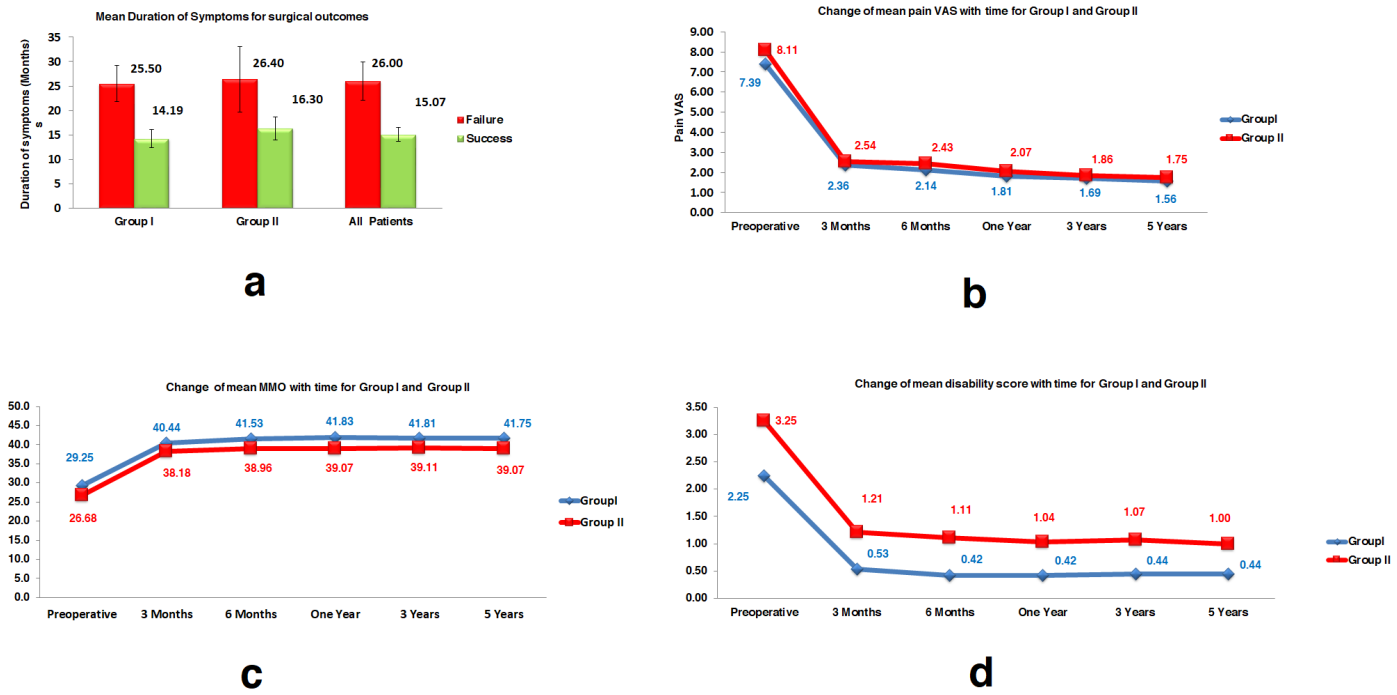

Figure 2

a) Preoperative duration of symptoms in relation to treatment outcome, b) Change of mean pain visual analog scale (VAS) with time, c) Change of mean maximal mouth opening (MMO) with time, d) Change of mean disability scores with time