

## THE EFFECT OF ULTRASOUND GUIDED VERSUS CONVENTIONAL ARTHROCENTESIS IN TREATMENT OF TEMPOROMANDIBULAR JOINT INTERNAL DERANGEMENT: A COMPARATIVE STUDY

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### ABSTRACT

**Objectives:** The objective of this research was to evaluate the impact of Ultrasound-guided arthrocentesis compared to conventional arthrocentesis in managing internal derangement of the temporomandibular joint.

**Materials and Methods:** Our study involved 16 female individuals diagnosed with internal derangement of the temporomandibular joint, specifically anterior disk displacement with or without reduction. These participants were divided into two cohorts: a control group treated with conventional arthrocentesis and a test group administered ultrasound-guided arthrocentesis. Both groups received hyaluronic acid injection via a single needle double barrel cannula and underwent postoperative low-level laser therapy as supplementary therapy. The primary outcome assessed was the maximum mouth opening. Follow-up assessments were conducted at intervals of 2, 4-, 6-, 8-, and 12-weeks post-surgery.

**Results:** There were no notable variances observed between the two groups concerning the specified outcome. Nonetheless, both methods proved effective in enhancing mouth opening compared to measurements taken prior to the operation.

**Conclusion:** This research reinforces the efficacy of both ultrasound-guided and conventional arthrocentesis in addressing TMJ internal derangement. Nonetheless, additional investigation is necessary to elucidate the contribution of ultrasound to enhancing treatment results for TMJ disorders.

**KEYWORDS:** Ultrasound, Arthrocentesis, TMDs, Hyaluronic acid, Single needle double barrel cannula, and Low-level laser therapy.

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## INTRODUCTION

Temporomandibular disorders (TMDs) encompass a range of conditions impacting the joint and muscles responsible for controlling jaw movement<sup>[1]</sup>. TMD may result in pain and discomfort within the joint and neighboring muscles, alongside challenges in jaw movement and function. Various factors such as injury, arthritis, bruxism (teeth grinding), stress, and genetic predispositions can contribute to the development of TMD<sup>[2]</sup>.

Internal derangement (ID) of the temporomandibular joint is characterized by an alteration in the typical alignment between the articular disk and both the articular surfaces of the temporal bone and the condyle.<sup>[3]</sup> The functional aspects of disk displacement can be classified into two forms: anterior disk displacement with reduction and anterior disk displacement without reduction, also recognized as closed lock<sup>[4]</sup>.

Arthrocentesis involves flushing the joint space to eliminate inflammatory mediators or intra-articular adhesions, aiming to enhance jaw movement and reduce pain through hydraulic pressure generated by irrigating the superior joint space<sup>[5]</sup>. Various substances are utilized for injection during arthrocentesis, including hyaluronic acid, corticosteroids, and analgesics<sup>[1]</sup>.

The temporomandibular joint (TMJ) possesses intricate anatomy, and accurate identification of the superior joint space is sensitive to technique and demands experience. Ultrasound was initially introduced in 1991 by Nebeith YB and Speculand B to aid in visualizing the TMJ, addressing this challenge<sup>[7]</sup>.

In ultrasound imaging, the disk, which divides the space into lower and upper compartments, manifests as a thin, uniform hypo-to-isoechoic structure, with both compartments above and below similarly appearing black<sup>[8]</sup>.

Ultrasound enables dynamic observation of

the TMJ during jaw movement, aiding in needle insertion and circumventing complications associated with conventional techniques<sup>[9]</sup>.

## MATERIALS AND METHODS

The research adhered to ethical guidelines, receiving approval from the research ethical committee (Serial no. 1086). The study protocol was thoroughly explained to all potential participants, and written informed consent was obtained from each patient prior to their involvement. Sixteen patients experiencing temporomandibular joint internal derangement (disk displacement without reduction) suffering from limitation in mouth opening and pain with no clicking sounds, unresponsive to conservative treatment including analgesics, physiotherapy, and history of no response to splint therapy in the early stages of the internal derangement. Patients were randomly chosen from the outpatient clinic of the Oral and Maxillofacial Surgery Department. Treatment was performed in the operation room at the British university in Egypt hospital and the study was conducted from March 2021 till February 2023. Selection criteria for patients were as follows:

### Inclusion criteria

1. Females over 18 years of age having anterior disk displacement without reduction based on clinical symptoms which are limitation in mouth opening and pain.
2. Patients who have never undergone arthrocentesis.
3. Patients with history of no response to splint therapy in the early stages of the internal derangement

### Exclusion criteria

1. Patient with uncontrolled systemic diseases precluding administration of general anesthesia.

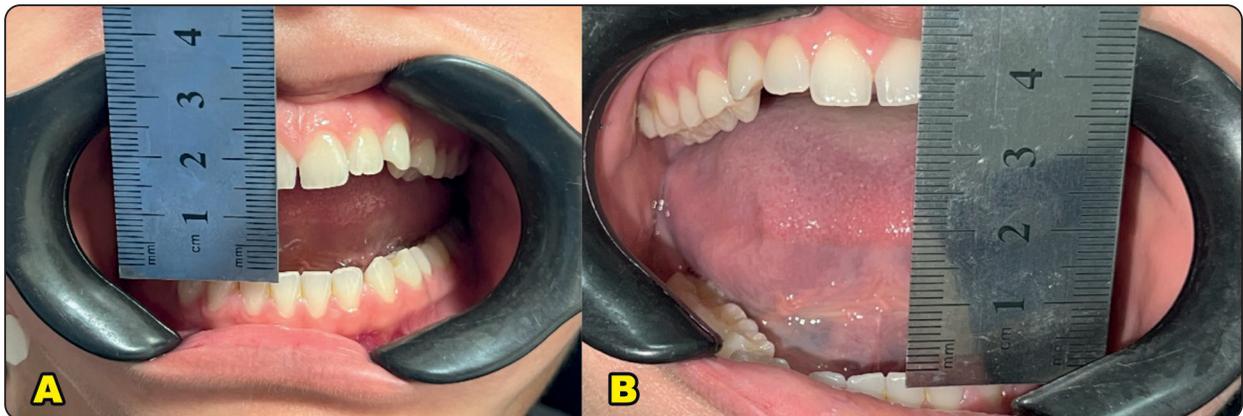


Fig. 1 (A) showing preoperative MMO. (B) showing postoperative MMO.

2. Handicaps and special needs patients as multiple follow up visits and accurate recording of the outcome is difficult and unreliable.

Patients were randomly allocated into two groups: a control group undergoing traditional arthrocentesis and a study group undergoing ultrasound-guided arthrocentesis. Randomization was conducted using a computer random sequence generator (Research Randomizer). In terms of allocation, patients were assigned random numbers ranging from 1 to 16, with odd numbers assigned to the control group and even numbers to the study group. The study was double-blinded, as the surgical procedures were conducted under general anesthesia. Both the patients and the outcome assessor were unaware of the group assignments.

The procedure was conducted under general anesthesia. A line was drawn from the tragus of the ear to the outer canthus of the eye (known as Holmud Hellsing's line). Lavage was performed using 100 ml of Ringer lactate solution, followed by the injection of 1 ml of Hyaluronic acid into the superior joint space. Fourteen days after the operation, low-level laser therapy (utilizing the Elexxion AG dental laser) was administered once weekly for 10 sessions. Each session lasted 10 minutes, with 5 minutes allocated to each side using GaAIIAs 910 nm laser with a power output of 400 M.

In the Ultrasound-guided group, the following protocol was followed: The transducer was positioned over the TMJ, aligned parallel to the long axis of the mandibular ramus. The transducer was adjusted until the best visualization was achieved. A single needle double barrel cannula was inserted in parallel to the transducer and advanced into the superior compartment while continuously visualizing its movement using ultrasound.

After the operation, the prescribed medications consist of Augmentin 1 gm orally twice daily for 7 days, Alphintern two tablets orally three times daily for 5 days, and Brufen 600 mg orally three times daily for 3 days.

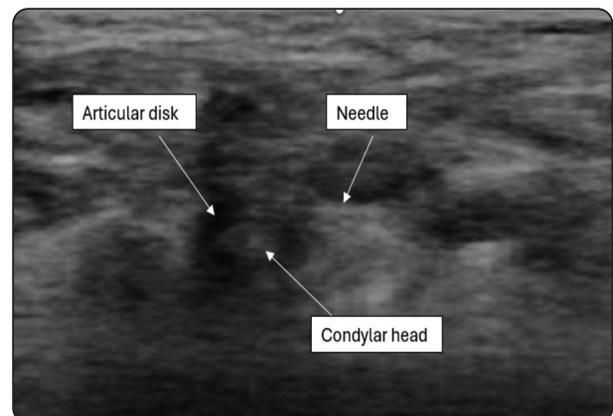


Fig. (2) Showing needle placement using ultrasound guidance.

**Follow-up:**

MMO evaluations were conducted at 2, 4, 6, 8, and 12 weeks postoperatively and compared to preoperative measurements.

**Statistical Analysis:**

The analysis comprised categorical data, which were represented as frequency and percentage values and evaluated using Fisher’s exact test. Numerical data underwent normality assessment via the Shapiro-Wilk test. Parametric data, depicted as mean and standard deviation values, were compared between groups using independent t-tests and within groups using repeated measures ANOVA followed by Bonferroni post hoc tests. Non-parametric data, expressed as median and interquartile range values, were analyzed using the Mann-Whitney U test and Friedman’s test, with Nemenyi post hoc tests applied for intragroup comparisons. A significance level of  $p < 0.05$  was utilized for all analyses. Statistical procedures were conducted using R statistical analysis software version 4.3.0 for Windows.

**RESULTS**

Intergroup and intragroup comparisons were conducted to evaluate the efficacy of ultrasound-guided arthrocentesis in contrast to the conventional technique and to gauge improvements within each group before and after the intervention.

**Intergroup comparisons:**

Based on our research findings, no notable disparities were observed in MMO between the control group (with an average of  $37.12 \pm 7.57$ )

and the intervention group (with an average of  $34.38 \pm 3.70$ ) after 12 weeks. The p-value of 0.371 indicates non-significance (“ns”), as shown in table(1).

TABLE (1) Intergroup comparison, mean and standard deviation (SD) values of MMO (mm).

Interval	MMO (mm) (mean±SD)		p-value
	Control	Intervention	
Pre-operative	27.00±3.34	24.12±3.87	0.134ns
After 2 weeks	32.25±11.13	29.50±6.61	0.558ns
After 4 weeks	36.38±8.02	32.00±4.93	0.210ns
After 6 weeks	36.25±8.22	33.00±2.67	0.306ns
After 8 weeks	37.12±7.57	34.00±3.63	0.310ns
After 12 weeks	37.12±7.57	34.38±3.70	0.371ns

\*; significant ( $p \leq 0.05$ ) ns; non-significant ( $p > 0.05$ )

**Intragroup comparisons:**

Our assessment of MMO revealed noteworthy differences in measurements across various time intervals ( $p < 0.001$ ). In intragroup comparisons, values recorded after 8 and 12 weeks were significantly higher compared to both the pre-operative measurement and the reading at 2 weeks ( $p < 0.001$ ). Additionally, the reading at 2 weeks showed a significant increase compared to the pre-operative measurement ( $p < 0.001$ ), as depicted in table (2).

TABLE (2) Intragroup comparison, mean and standard deviation (SD) values of maximum mouth opening (mm).

Interval	MMO (mm) (mean±SD)						p-value
	Pre-operative	After 2 weeks	After 4 weeks	After 6 weeks	After 8 weeks	After 12 weeks	
Control	27.00±3.34 <sup>C</sup>	32.25±11.13 <sup>B</sup>	36.38±8.02 <sup>AB</sup>	36.25±8.22 <sup>AB</sup>	37.12±7.57 <sup>A</sup>	37.12±7.57 <sup>A</sup>	<0.001*
Intervention	24.12±3.87 <sup>C</sup>	29.50±6.61 <sup>B</sup>	32.00±4.93 <sup>AB</sup>	33.00±2.67 <sup>AB</sup>	34.00±3.63 <sup>A</sup>	34.38±3.70 <sup>A</sup>	<0.001*

Values with different superscript letters within the same horizontal row are significantly different \*; significant ( $p \leq 0.05$ ) ns; non-significant ( $p > 0.05$ )

## DISCUSSION

The management of internal derangement (ID) poses challenges owing to its multifactorial etiology and pathogenesis. The principal objective in addressing disk displacement revolves around alleviating pain and ameliorating limitations in movement<sup>[10]</sup>. This study aimed to investigate the impact of ultrasound-guided arthrocentesis compared to conventional arthrocentesis in the treatment of temporomandibular joint internal derangement.

Arthrocentesis, coupled with intra-articular drug administration, demonstrates favorable outcomes in reinstating TMJ functions among individuals with TMJ internal derangement. Consequently, it represents a preferred treatment modality for patients with TMJ internal derangement who have not responded to conservative interventions. These findings are consistent with prior studies, such as those conducted by Nitzan et al., which reported a 91% success rate in 17 cases treated with arthrocentesis<sup>[11]</sup>.

The integration of ultrasound (US) in treating temporomandibular disorders (TMD) is regarded as innovative, offering advantages over traditional imaging modalities. Nonetheless, the efficacy of US in enhancing treatment outcomes for TMD remains a subject of debate<sup>[12]</sup>.

The restriction in mouth opening highlights the necessity for addressing internal derangement to regain functionality. Our research results indicate that there was no notable disparity in MMO between the control group ( $37.12 \pm 7.57$ ) and the intervention group ( $34.38 \pm 3.70$ ) after 12 weeks, with a p-value of 0.371 (non-significant).

In three studies conducted by Sivri et al, Şentürk et al and Antony et al <sup>[6], [13], [14]</sup>, alterations in MMO served as an outcome measure. All three studies documented a marked enhancement in MMO for both the cohorts undergoing arthrocentesis, whether

with or without US guidance. In the US-guided arthrocentesis group, the post-treatment MMO improvement varied from 5.6 to 16 mm. Regarding conventional arthrocentesis, MMO enhancement ranged from 4.1 mm to 10.3 mm.

Only one study by Antony et al <sup>[14]</sup> documented a more substantial MMO enhancement with US-guided arthrocentesis compared to conventional arthrocentesis, while the other two studies by Sivri et al and Şentürk et al <sup>[6], [13]</sup> did not identify significant differences between the two groups. The difference between our results and the study by Antony et al <sup>[14]</sup> showing improvement in MMO may be attributed to the inclusion of both males and females in their study, whereas our study solely involved females. Some studies suggest that hormonal factors may influence the severity of the condition, potentially impacting the outcomes <sup>[15], [16]</sup>.

Our evaluation of MMO indicated a significant discrepancy in values assessed at different time points ( $p < 0.001$ ). Within the identical group, comparisons illustrated that the values recorded after 8 and 12 weeks exhibited a considerable increase compared to both the pre-operative assessment and the reading after 2 weeks ( $p < 0.001$ ). Moreover, the measurement taken after 2 weeks showed a significant elevation compared to the pre-operative value ( $p < 0.001$ ).

In conclusion, this study highlights the effectiveness of both ultrasound-guided and conventional arthrocentesis in addressing TMJ internal derangement. However, additional research is necessary to ascertain the specific impact of ultrasound on improving treatment outcomes for TMJ disorders.

### Recommendations:

Future studies should consider evaluating other outcomes such as pain, number of needle attempts and operation's duration to evaluate the effectiveness of Ultrasound guidance in improving these outcomes.

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