

## Original Research

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### KEYWORDS:

Temporomandibular joint, Arthroscopy, Hyaluronic acid, Mouth opening, Joint sound, Bite force

## Efficacy of Hyaluronic Acid Deposition Post TMJ Arthroscopy Versus Conventional TMJ Arthroscopy for Patients Suffering from Internal Derangement: A Clinical Study

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### ABSTRACT:

**Aim:** To evaluate and contrast the clinical efficacy of supplementary intra-articular hyaluronic acid (HA) administration following arthroscopic lysis and lavage (ALL) against ALL monotherapy in patients diagnosed with Stage III and IV temporomandibular joint internal derangement (TMJ-ID), according to Wilkes' classification.

**Subjects and Methods:** Twenty patients with TMJ-ID were randomized into two equal groups (n = 10): Group I (ALL + HA) and Group II (ALL alone). Pain intensity, maximum interincisal opening (MIO), lateral/protrusive movements, joint sounds, and bite force, were evaluated clinically and via MRI at baseline, immediately post-procedure, and at 6 months.

**Results:** While both therapeutic protocols yielded sustained pain alleviation throughout the 6-month period, the adjunctive HA cohort demonstrated significantly superior pain reduction in the early-to-mid postoperative phase alongside accelerated recovery in protrusive movement ( $p < 0.05$ ). At the 6-month mark, both groups exhibited equivalent improvements in MIO, lateral mobility, bite force, and Radiographic evaluation via MRI demonstrated no statistically significant intergroup variations ( $p > 0.05$ ) regarding articular disc position or joint structural integrity. Masticatory efficiency and joint sound abatement improved comparably across both arms.

**Conclusion:** Adjunctive HA after ALL enhances early postoperative pain relief and mobility recovery. However, given equivalent 6-month functional and structural outcomes, ALL alone remains an effective standard therapy for advanced TMJ-ID.

## INTRODUCTION

Temporomandibular joint internal derangement (TMJID) represents a common and clinically challenging subset of temporomandibular disorders (TMDs). Characterized pathologically by an anatomical misalignment between the articular disc and the mandibular condyle, TMJID typically presents as localized arthralgia, restricted mandibular movement, and progressive functional impairment.<sup>(1)</sup>

The disease follows a well-documented clinico-radiological continuum, most frequently classified using the Wilkes staging system<sup>(2)</sup>. This progression originates with reversible disc displacement with reduction (DDWR) and advances to non-reducing

displacement as retrodiscal tissue elasticity degrades. Over time, persistent mechanical obstruction leads to disc deformation, osteoarthritic articular degeneration, and potential tissue perforation <sup>(3)</sup>

The etiology of TMJ-ID is inherently multifactorial, arising from a complex interplay of mechanical, functional, and systemic stressors. Primary risk factors include parafunctional habits, acute macrotrauma, occlusal instability, and structural degradation of the articular components <sup>(4)</sup>. Consequently, early identification and timely therapeutic intervention are paramount to mitigating irreversible articular breakdown and chronic physical disability <sup>(5)</sup>.

Diagnosing TMD relies primarily on comprehensive clinical histories and physical examinations. Classic symptoms include pain localized to the preauricular, masseter, or temporal regions, which is typically exacerbated by jaw function such as chewing or opening. The presence of joint noises such as clicking or crepitus is also characteristic, whereas pain unaffected by movement generally suggests an alternative orofacial origin<sup>(6)</sup>

Management of TMJ-ID follows a stepped care approach. Initial conservative management prioritizes non-invasive options, including patient education, behavioral modification, pharmacotherapy (NSAIDs, muscle relaxants), physical therapy, and occlusal splints <sup>(7)</sup>. Surgical intervention is reserved strictly for refractory cases failing exhaustive conservative treatment <sup>(8)</sup>.

The purpose of this study was to evaluate whether adjunctive intra-articular hyaluronic acid (HA) following arthroscopic lysis and lavage (ALL) yields superior clinical outcomes compared to ALL monotherapy with Ringer's lactate in TMJ-ID. We hypothesized that post-ALL HA instillation confers greater therapeutic efficacy. Outcomes were assessed by comparing pre- and post-treatment pain (VAS), maximum interincisal opening (MIO), bite force dynamics, and MRI findings between both cohorts.

## MATERIALS AND METHODS

### Study Design and Setting

This randomized clinical trial was conducted in the Department of Oral and Maxillofacial Surgery, Faculty of Dental Medicine (Boys), Al-Azhar University, Cairo, Egypt.

### Ethical Considerations

The study protocol was reviewed and approved by the Ethics Committee of the Faculty of Dental Medicine (Boys), Al-Azhar University. (Approval Code:-----). Prior to enrollment, all participants received a detailed explanation of the research objectives, treatment protocols, and potential risks, and provided written informed consent.

### Patient Selection

Patients were evaluated for eligibility based on the following criteria:

**Inclusion Criteria:** Age  $\geq 18$  years (both sexes), Clinical and radiological diagnosis of TMJ internal derangement (Wilkes Stage III or IV), Refractory symptoms following conservative, non-invasive management. **Exclusion Criteria:** Co-existing myofascial pain, polyarthritis, or advanced degenerative joint disease, History of previous TMJ surgical interventions, Presence of TMJ ankylosis, intra-articular neoplasms, or active cutaneous infections over the joint region, Uncontrolled systemic conditions contraindicating surgical procedures or general anesthesia, Known hypersensitivity to hyaluronic acid and Inability or unwillingness to comply with scheduled follow-up visits.

### Grouping and Randomization

Enrolled participants were randomly allocated into two equal groups: **Group I (Study Group):** Treated with arthrocentesis and lavage (ALL) using Ringer's lactate solution, followed by intra-articular injection of hyaluronic acid (HA). **Group II (Control Group):** Treated with ALL using Ringer's lactate solution alone.

### Preoperative Assessment

Clinical Evaluation

All participants underwent a baseline clinical evaluation comprising: Medical and Dental History, Physical Examination: Manual palpation of the TMJ and masticatory musculature to assess localized tenderness and functional dynamics. Mandibular Kinematics: Maximum interincisal opening (MIO), lateral excursions, and protrusion were measured in millimeters using a Vernier caliper. Pain Assessment: Evaluated using a self-administered Visual Analog Scale (VAS) ranging from 0 (no pain) to 10 (worst imaginable pain)<sup>(22)</sup>. Bite Force Measurement: Objective recording of maximum bite force at baseline. Joint Sounds: Presence of mechanical joint sounds (clicking, popping, or crepitus) was determined via clinical history and manual joint palpation.

Radiographic Evaluation Baseline (MRI) of the TMJ was obtained for all patients to confirm the clinical diagnosis of internal derangement and evaluate joint morphology prior to treatment.

## Interventions:

All patients were hospitalized for preoperative preparation, including routine laboratory investigations and necessary multispecialty consultations. procedures were performed under general anesthesia with standard aseptic preparation and external auditory canal protection. Surgical access was established along the canthotragal line: the inflow portal (glenoid fossa) was marked 10 mm anterior to the mid-tragus and 2 mm inferior to the line, while the outflow portal (articular eminence) was placed 10 mm anterior and 10 mm inferior to the inflow site.

Patients were placed in a supine position with the head rotated to the contralateral side. The superior joint space (SJS) was first distended using a 3 mL mixture of 2% lidocaine and normal saline, followed by joint backwash aspiration. A 0.5 cm stab incision was then made to establish the primary fossa puncture. A sharp trocar and arthroscopic sheath were advanced toward the inferolateral aspect of the zygomatic arch and stepped inferiorly into the SJS. Proper intra-articular cannula placement was verified by observing irrigant fluid fluctuations during manual manipulation of the mandible. An outflow puncture was subsequently established at the anterolateral corner of the superior joint space (SJS) to enable fluid drainage (Level II operative arthroscopy).

The arthroscope, fitted with a 30° degree lens camera, was introduced into the SJS. Comprehensive endoscopic arthrocentesis and lavage were executed using 150–300 mL of Ringer's lactate solution per joint across both groups (Figure a). Following joint irrigation, patients in Group A received an intra-articular injection of hyaluronic acid (20 mg / 2 mL). The arthroscope and cannula were withdrawn, and puncture sites were closed using 5-0 non-resorbable sutures before applying an antibiotic-collagenase dressing. Prior to patient extubation, passive jaw manipulation was performed 5–10 times, and maximum interincisal opening (MIO) was recorded.

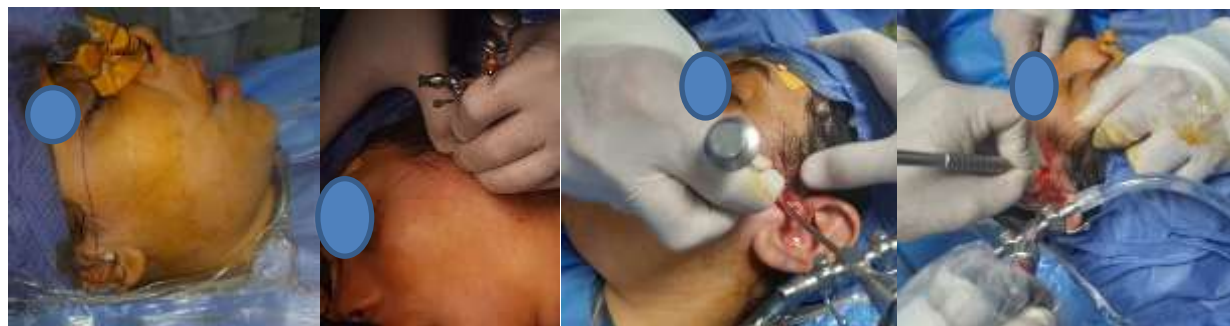


**Figure (a):** showing canthotragal line, inflow puncture, camera sheath and sharp trocar in place, arthroscopy with camera and probe .

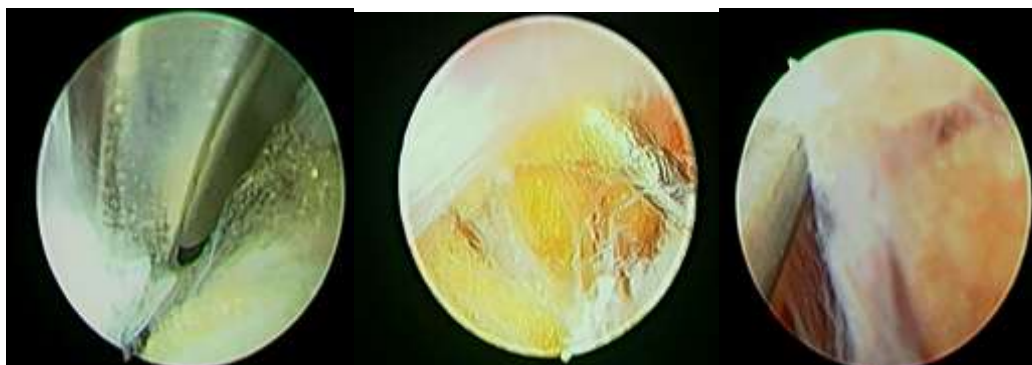


**Figure b:** intra articular image showing , grasper,needle , second puncture sheath.

## Post-operative Management:

Immediately post-procedure, a preauricular pressure dressing was applied and maintained for 48 hours. Patients were prescribed a course of amoxicillin/clavulanic acid (625 mg) along with combination analgesia (ibuprofen 400 mg and paracetamol 500 mg). Cryotherapy was recommended for the first 24 hours (applied for 20 minutes at a time), followed by moist heat therapy until postoperative edema fully resolved.

**Rehabilitation and Dietary Modifications** Patients resumed wearing their full-coverage occlusal stabilization splints on the first postoperative day. Functional physiotherapy—focusing on vertical opening, lateral excursions, and protrusion range-of-motion exercises—commenced 24 hours postoperatively. Dietary instructions specified a liquid-to-soft diet for the first 3 months, after which patients gradually transitioned back to a regular diet while continuing to avoid hard or mechanically demanding foods. Cutaneous sutures were removed at 1 week postoperatively.

**Postoperative Clinical and Radiological Assessments** Evaluations were conducted at 1 and 2 weeks, and at 1, 3, and 6 months postoperatively. Outcome measures included:

- **Pain Intensity:** Evaluated using a Visual Analog Scale (VAS), recorded daily during the first week and at each scheduled follow-up visit through 6 months.
- **Mandibular Kinematics:** Maximum interincisal opening (MIO), as well as lateral and protrusive excursions, were measured in millimeters using an electronic Vernier caliper.
- **Joint Sounds:** Presence or absence of TMJ clicking, popping, or crepitus was systematically evaluated and documented.
- **Bite Force:** Recorded bilaterally at the first molars and the incisal region using a calibrated strain-gauge transducer.
- **Radiological Assessment:** MRI was performed at 6 months postoperatively and compared with baseline imaging to evaluate changes in articular disc position (Figures 1, 2).

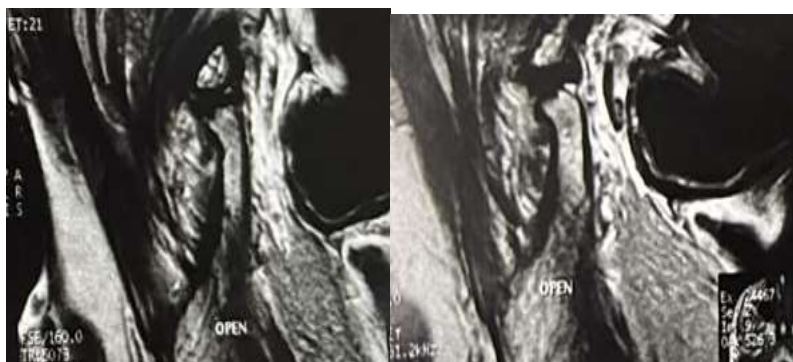


**Figure (1)** Showing MRI preoperative open view right and left group I osteoarthritis changes in both sides.

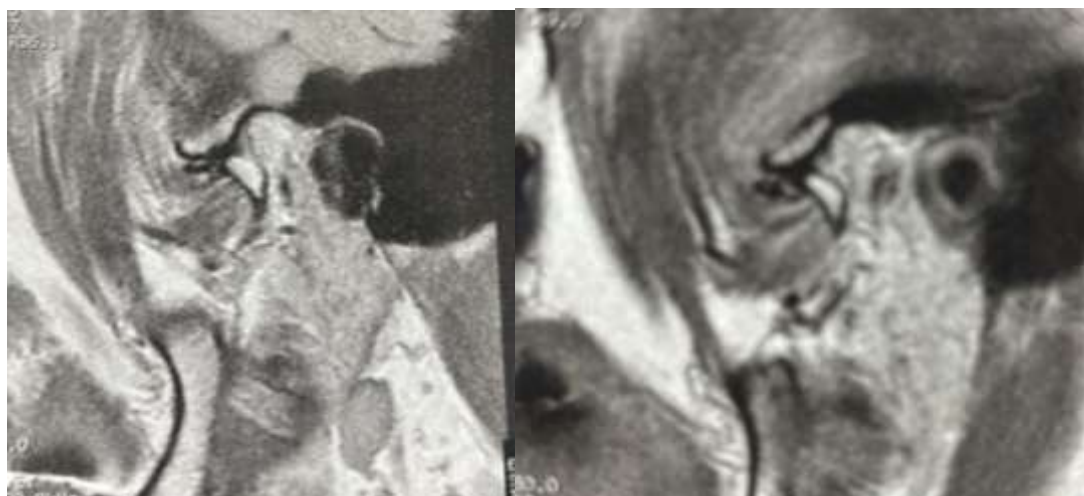


**Fig (2):** Preoperative open-mouth MRI view of the right and left groups, showing bilateral DDWoR, group II.

Data were analyzed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were tested for normality using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Normally distributed (parametric) quantitative data were expressed as mean  $\pm$  standard deviation (SD) and range. Categorical (qualitative) variables were reported as frequency counts (n) and percentages (%).

## RESULT:

### Demographic Data

Demographic comparison demonstrated no statistically significant differences between the two study groups at baseline. The mean age was  $29.33 \pm 8.73$  years in Group I and  $31.83 \pm 6.88$  years in Group II ( $p = 0.594$ ). Both cohorts were comprised entirely of female participants (100 %,  $p = 1.000$ ).

### Pain Outcomes (VAS)

Baseline pain intensity for the right TMJ was comparable between groups ( $p = 0.573$ ), whereas baseline scores for the left side showed a statistically significant difference ( $p = 0.049$ ). Group II demonstrated significantly lower left TMJ pain scores during the early postoperative phase (weeks 1–2;  $p \leq 0.01$ ). Conversely, Group I achieved significantly lower pain scores at later time points: right TMJ at 2 and 3 months ( $p \leq 0.047$ ) and left TMJ at 3 months ( $p = 0.004$ ). Both groups demonstrated highly significant longitudinal pain reduction over the course of the study ( $p < 0.001$ ) (Table 1), confirming the overall therapeutic efficacy of both interventions. ALL alone (Group II) yielded superior early-phase pain relief on the left side, the addition of hyaluronic acid (Group I) resulted in significantly enhanced long-term pain reduction at 2 and 3 months postoperatively.

**Table (1):** Comparison of pain scores (VAS) between study groups over time for right and left TMJs.

| Time | Pain (VAS score) Right |                 |         | Pain (VAS score) Left |                 |         |
|------|------------------------|-----------------|---------|-----------------------|-----------------|---------|
|      | Group I                | Group II        | p-value | Group I               | Group II        | p-value |
| Pre  | $7.67 \pm 0.88$        | $8.00 \pm 1.10$ | 0.573   | $7.25 \pm 0.61$       | $6.50 \pm 0.55$ | 0.049*  |
| 1st  | $8.17 \pm 0.41$        | $7.67 \pm 0.52$ | 0.092   | $8.67 \pm 0.52$       | $7.33 \pm 0.52$ | 0.001*  |
| 2nd  | $8.17 \pm 0.41$        | $7.83 \pm 0.75$ | 0.363   | $8.33 \pm 0.52$       | $7.17 \pm 0.75$ | 0.011*  |
| 3rd  | $7.67 \pm 0.75$        | $6.83 \pm 0.98$ | 0.130   | $7.67 \pm 1.03$       | $6.83 \pm 0.75$ | 0.141   |
| 4th  | $7.33 \pm 1.03$        | $6.33 \pm 1.63$ | 0.234   | $7.00 \pm 0.63$       | $6.00 \pm 1.10$ | 0.082   |
| 5th  | $7.00 \pm 0.89$        | $6.17 \pm 1.79$ | 0.399   | $6.75 \pm 1.08$       | $5.50 \pm 1.05$ | 0.070   |

|         |           |           |        |           |           |        |
|---------|-----------|-----------|--------|-----------|-----------|--------|
| 6th     | 6.42±1.20 | 5.83±1.17 | 0.414  | 6.50±0.55 | 6.00±1.67 | 0.503  |
| 7th     | 6.25±1.17 | 5.83±1.60 | 0.618  | 6.50±1.05 | 5.67±1.37 | 0.263  |
| 2w      | 4.17±1.21 | 5.17±1.47 | 0.245  | 4.83±0.75 | 4.67±1.03 | 0.756  |
| 1M      | 3.50±1.05 | 4.50±1.31 | 0.188  | 4.50±0.84 | 3.83±0.75 | 0.177  |
| 2M      | 2.50±0.73 | 4.17±0.75 | 0.047* | 2.67±0.77 | 3.67±0.82 | 0.060  |
| 3M      | 2.17±0.63 | 4.00±0.89 | 0.026* | 1.67±0.48 | 3.83±0.98 | 0.004* |
| F-test  | 60.44     | 53.722    | --     | 59.205    | 56.202    | --     |
| p-value | <0.001**  | <0.001**  | --     | <0.001**  | <0.001**  | --     |

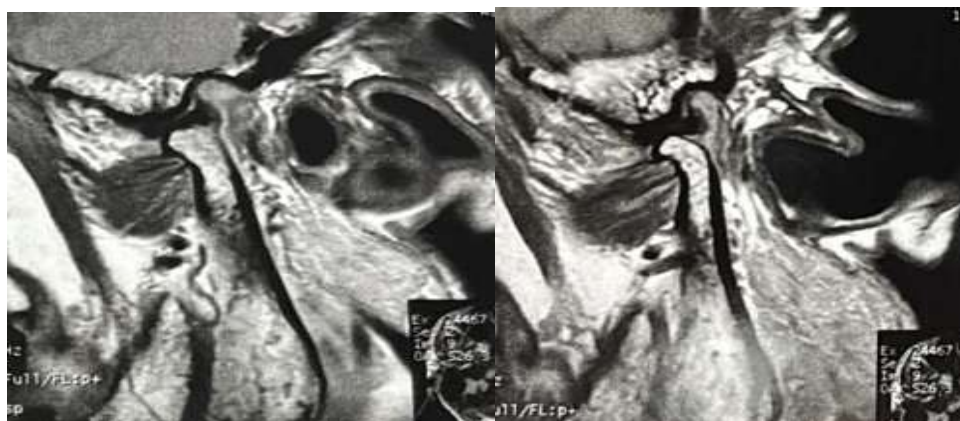
Intergroup comparisons showed no statistically significant differences in MIO, lateral excursions, or protrusion across any time point ( $p > 0.05$ ). Baseline MIO was virtually identical between Group I ( $26.93 \pm 2.47$  mm) and Group II ( $27.00 \pm 2.60$  mm;  $p = 0.959$ ). While both treatment modalities significantly enhanced mandibular function over 6 months ( $p < 0.05$ ; Table 2), no significant differences were observed between the groups at 3 or 6 months. Consequently, both treatments proved equally effective at restoring range of motion

**Table (2):** Comparison of MIO (mm), Right + Left Lateral excursion (mm) and Protrusion (mm) between study groups over time for right and left TMJs.

| Range of mandibular excursion | MIO (mm)    |             |           | Right Lateral excursion (mm) |           |           | Left Lateral excursion (mm) |           |           | Protrusion (mm) |           |           |
|-------------------------------|-------------|-------------|-----------|------------------------------|-----------|-----------|-----------------------------|-----------|-----------|-----------------|-----------|-----------|
|                               | Grou p I    | Grou p II   | P-value # | Grou p I                     | Grou p II | P-value # | Grou p I                    | Grou p II | P-value # | Grou p I        | Grou p II | P-value # |
| Pre Op.                       | 26.93 ±2.47 | 27.00 ±2.60 | 0.959     | 4.17±0.52                    | 4.17±0.52 | 1.000     | 5.00±1.05                   | 5.12±1.11 | 0.856     | 1.65±0.48       | 2.10±0.61 | 0.528     |
| 2nd D                         | 24.85 ±2.15 | 25.18 ±4.17 | 0.865     | 3.05±0.76                    | 3.08±0.89 | 0.950     | 3.55±0.46                   | 3.62±0.82 | 0.866     | 0.92±0.27       | 1.90±0.55 | 0.081     |
| 1ST W                         | 32.50 ±3.62 | 31.17 ±3.87 | 0.353     | 5.20±0.85                    | 4.95±0.91 | 0.634     | 5.52±0.53                   | 5.33±0.61 | 0.589     | 2.33±0.68       | 3.20±0.93 | 0.105     |
| 2ND W                         | 35.58 ±1.86 | 37.17 ±3.13 | 0.311     | 6.12±0.58                    | 6.12±0.80 | 1.000     | 6.50±0.74                   | 6.25±0.52 | 0.514     | 2.97±0.74       | 3.53±0.82 | 0.236     |
| 3M                            | 37.13 ±2.36 | 38.72 ±2.21 | 0.257     | 6.20±0.75                    | 6.45±0.46 | 0.503     | 6.42±0.58                   | 6.67±0.61 | 0.484     | 3.08±0.74       | 3.62±0.78 | 0.250     |
| 6M                            | 36.17 ±2.04 | 38.33 ±1.86 | 0.084     | 6.07±0.68                    | 6.28±0.23 | 0.479     | 6.47±0.75                   | 6.92±0.40 | 0.224     | 2.75±0.58       | 3.18±0.81 | 0.312     |
| F-test                        | 27.634      | 24.24       | --        | 26.618                       | 26.789    | --        | 24.439                      | 26.609    | --        | 28.391          | 23.743    | --        |
| p-value                       | <0.001**    | <0.001**    | --        | <0.001**                     | <0.001**  | --        | <0.001**                    | <0.001**  | --        | <0.001**        | <0.001**  | --        |

Baseline joint sounds were comparable ( $p = 0.296$ ). Group I (HA) achieved significantly faster right-side sound resolution at 2 weeks (83.3% vs. 16.7%;  $p = 0.021$ ), but 6-month intergroup differences were non-significant ( $p = 0.221$ ). No left-side

differences occurred at any interval ( $p > 0.05$ ). Bite force did not differ significantly between groups at any time point or vector ( $p > 0.05$ ), though Group I showed a non-significant trend toward higher 6-month values. MRI revealed equivalent 6-month disc position outcomes ( $p = 0.248$ ), with disc displacement without reduction improving from 83.3% to 66.7% in Group I and 50.0% to 33.3% in Group II (Fig. 3). Thus, HA supplementation accelerated early sound resolution without enhancing long-term acoustic, functional, or anatomical outcomes compared to arthroscopy alone. Figure(4).



**Fig(3):** MRI postoperative open-mouth view of the right and left group I, indicating bilateral bone remodeling..



**Fig(4):** MRI postoperative open-mouth view of the right and left group II, indicating bilateral reducible disc in both sides..

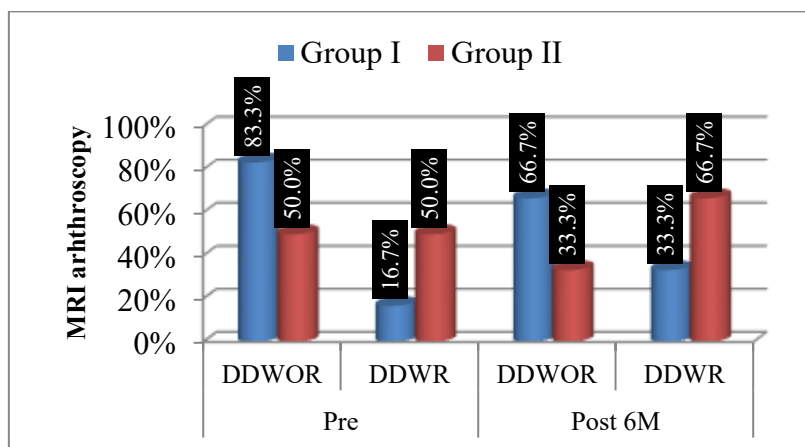


**Figure (5):** Comparison between group I and group II according to MRI.

## DISCUSSION

The primary objective of this study was to evaluate the efficacy of hyaluronic acid (HA) deposition following temporomandibular joint arthroscopic lysis and lavage (TMJ ALL) versus TMJ ALL alone in achieving superior pain relief, maximum mouth opening (MIO), lateral excursion, protrusion, joint noise reduction, bite force, and MRI improvements six months postoperatively.

The demographic profile demonstrated homogeneity across groups, as all included patients were female. This female predominance is driven by both biological and psychosocial variables; specifically, estrogen modulates joint laxity and pain perception, while higher rates of healthcare-seeking behavior among women likely contribute to the observed clinical prevalence<sup>(9)</sup>. This finding aligns with the results reported by Berger et al.<sup>(10)</sup>.

Regarding pain outcomes, the results demonstrated that while both modalities were effective, the baseline equivalence of the study groups suggests that the superior long-term pain reduction observed in Group I (ALL + HA) was likely a direct therapeutic effect. This reduction is achieved through the synergistic effects of mechanical lubrication and biological modulation.<sup>(11)</sup> These findings align with those of **Flores-Fraile et al.**<sup>(12)</sup>, but contradict the conclusions drawn by **Xie et al.**<sup>(13)</sup>, who reported no significant difference between HA and placebo.

In terms of MIO, the findings suggest that while both modalities are equally effective in rehabilitating range of motion, the addition of HA did not confer a superior mechanical advantage over arthroscopy alone. The primary driver of functional recovery appears to be the surgical release of adhesions rather than the specific adjunct utilized. These results are consistent with **Li et al.**<sup>(14)</sup> however, they diverge from the meta-analysis by **Xu et al.**<sup>(15)</sup>, which suggested that HA supplementation significantly enhances vertical opening compared to irrigation alone.

Concerning joint noise reduction, the group receiving HA experienced a more rapid reduction in right TMJ sounds during the second postoperative week, suggesting that HA helps maintain smooth gliding to mitigate joint noise. Otherwise, both groups achieved similar improvements in joint sounds over the follow-up period, demonstrating that the total elimination of joint noise is not a guaranteed outcome. This observation aligns with findings reported by **Clark et al.**<sup>(16)</sup>, but diverges from the results of **Godden et al.**<sup>(17)</sup>, who reported that the majority of patients remained completely noise-free postoperatively.

Regarding bite force outcomes, intragroup analysis revealed a statistically significant increase in maximum voluntary bite force from baseline to final follow-up ( $p < 0.05$ ). However, intergroup analysis revealed no significant differences at any time point during follow-up, suggesting that both treatment modalities were equally effective in restoring masticatory function. This is in accordance with **Ángelo et al.**<sup>(18)</sup>. Similarly, **Bakke et al.**<sup>(19)</sup> observed that most patients regain the ability to tolerate soft-to-medium food textures with minimal chewing-related discomfort. Magnetic resonance imaging analysis revealed no statistically significant intergroup differences in disc position at baseline ( $p = 0.221$ ) or at the six-month follow-up ( $p = 0.24$ ). Thus, the clinical improvements observed in this study were not strictly mirrored by radiological repositioning of the disc, confirming that clinical success (improved bite force and pain relief) often occurs independently of radiological success (disc repositioning). This finding agrees with Moses et al.<sup>(20)</sup>, who noted that 92% of patients still presented with anterior disc displacement post-surgery despite improved mobility. However, the MRI outcomes in the present study diverge from the findings of da Silva et al.<sup>(21)</sup>, who observed improved disc positions in 63% of patients following ALL.

Postoperative complications were minimal and equally distributed between the two cohorts. Transient numbness in the preauricular region occurred in two patients (one in each group), both of whom experienced spontaneous resolution during the follow-up period. Additionally, two cases of minor intraoperative hemorrhage occurred; however, hemostasis was successfully achieved through local compression without further intervention. These safety outcomes accord with those reported by Tsuyama et al.<sup>(22)</sup>.

## LIMITATIONS

Limitations of this study include a small sample size, potential placebo effects, a lack of double-blinding during clinical assessment, and the use of a single-dose administration protocol, which may underestimate the full therapeutic potential of HA compared to multi-dose regimens.

## CONCLUSION

Both TMJ arthroscopy alone and TMJ arthroscopy supplemented with hyaluronic acid (HA) effectively reduce pain and improve mandibular function (MIO, lateral excursions, and protrusion) over six months. While both modalities reliably restore mobility, HA supplementation offers significantly greater pain reduction at 2–3 months postoperatively. However, structural MRI outcomes and overall functional recovery rates remain comparable between groups. Ultimately, both approaches are effective for functional restoration, though HA may provide superior medium-to-long-term symptomatic relief.

## DECLARATION

### Conflict of interest

Authors declare that there is no conflict of interest.

### Source of funding

There are no funds procured

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