

Clinical and Radiographic evaluation of the efficacy of Injectable PRF (platelet- rich fibrin) in management of Temporomandibular joint Internal Derangement: A Randomized Controlled Clinical Study

Enas Ismail Abd Alrahman

enas_ismail@dent.suez.edu.eg

Suez canal university

Mohamed hassan Eid

Suez canal university

Asmaa yousri Abd Allah

Suez Canal University

Mohamed A. Elsholkamy

Suez canal university

Research Article

Keywords: temporomandibular joint, internal derangement, injectable platelet-rich fibrin, hyaluronic acid

Posted Date: October 7th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-11029445/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Clinical and Radiographic evaluation of the efficacy of Injectable PRF (platelet- rich fibrin) in management of Temporomandibular joint Internal Derangement: A Randomized Controlled Clinical Study

****Enas Ismail Abd Alrahman, teaching assistant at oral and maxillofacial surgery department, faculty of Dentistry, Suez Canal University, Ismailia, Egypt

Email: enas_ismail@dent.suez.edu.eg

ORCID ID: 0009-0004-2854-332X

Mohamed Hassan Eid, associate professor at oral and maxillofacial surgery department, faculty of Dentistry, Suez Canal University. Ismailia, Egypt

Email: mohamed_hassan@dent.suez.edu.eg

ORCID ID: 0009-0000-4423-1095

Asmaa Yousri Abd Allah, associate professor at oral and maxillofacial radiology, faculty of Dentistry, Suez Canal University, Ismailia, Egypt

Email: asmaa_yousry@dent.suez.edu.eg

Mohamed A. Elsholkamy, professor at oral and maxillofacial surgery department, faculty of Dentistry, Suez Canal University, Ismailia, Egypt

Email: mohamed_elshlkami1@dent.suez.edu.eg

ORCID ID 0009-0000-0367-6573

abstract

Purpose: This study aimed to evaluate clinically and radiographically the efficacy of injectable platelet-rich fibrin (I-PRF) intraarticular injection in the management of temporomandibular joint (TMJ) internal derangement. This research addressed the following primary question: Did the administration of I-PRF lead to statistically significant clinical improvements (e.g., reduction in joint pain and increase in maximum mouth opening [MMO]) and positive MRI changes (change in disc position)?

Methods: Twenty female patients who were diagnosed with internal derangement and did not respond to conservative treatment were enrolled in this randomized clinical investigation. Patients were divided into two equal groups at random: the study group received an intraarticular injection of I-PRF after arthrocentesis, whereas the control group received an intraarticular injection of hyaluronic acid (HA) after arthrocentesis. Maximum mouth opening (MMO), joint clicking, lateral and protrusive movements, and pain severity as measured by the Visual Analog Scale (VAS score) were all included in the clinical examination. MRI was done both before and six months after surgery.

Results: Over time, both groups showed notable improvements in pain and MMO following surgery. MMO was similar in the I-PRF and HA groups at six months. At six months, however, the I-PRF group's pain score was statistically lower than the HA group's. Both groups saw significant improvements in TMJ clicking. Both groups' MRI results showed sustained anterior disk displacement.

Conclusion: I-PRF was successful in treating TMJ internal derangement, especially in terms of increasing mouth opening, lowering joint clicking, and resolving joint effusion.

Keywords: temporomandibular joint, internal derangement, injectable platelet-rich fibrin, hyaluronic acid

The study protocol was retrospectively registered on ClinicalTrials.gov (Identifier: NCT07789860).

Date of registry: 30/7/2026

Date of acceptance: 26/8/2026

Introduction

The temporomandibular joint is one of the body's most complex joints. Temporomandibular disorders are particularly troublesome for patients because they can cause pain, disrupt oral functions, and pose challenges for diagnosis and treatment (1). Common signs include limited mandibular movement, pain or tension in the masseter and jaw muscles, joint discomfort affecting movement, and sounds like clicking or crepitus in the TMJ (2). Diagnosis mainly relies on the patient's history, current symptoms, and the clinician's physical examination and radiographic interpretation skills. Significant efforts to visualize this joint focus on the disc, especially in TMJ internal dysfunction (3). MRI is currently the most reliable method for locating the disc, with studies showing 90–95% accuracy in detecting disc abnormalities when compared to surgical and postmortem findings (4). Treatment aims to restore normal mandibular motion and reduce pain. Conservative approaches such as dietary modifications, medications, physical therapy, and splints are typically first-line; if these are ineffective, procedures like arthrocentesis, arthroscopy, or open surgery are considered (5).

Arthrocentesis is a minimally invasive procedure aimed at improving joint mobility, breaking down adhesions, restoring synovial fluid viscosity, and removing inflammatory mediators. It can be done with or without intra-articular injections of various medicines, such as steroids, hyaluronic acid, ozone, or platelet-rich plasma (6). First-generation platelet concentrates, or platelet-rich plasma (PRP), are made by centrifuging blood and are used in liquid or gel form after activation with calcium and thrombin, creating a weak fibrin network. Due to its antimicrobial, analgesic, and anti-inflammatory properties, PRP is approved for use. However, it requires anticoagulants that may hinder wound healing. To address this, a second-generation plasma concentrate called platelet-rich fibrin (PRF) was developed (7, 8). PRF matrices are obtained from blood without anticoagulants, with traditional PRF forming a three-dimensional fibrin network via centrifugation, while low-speed centrifugation produces a new liquid form (9).

The purpose of this study was to assess the effectiveness of injectable platelet-rich fibrin I-PRF in treating TMJ internal derangement.

Patients and Methods

I. Study design

A parallel-group randomized controlled clinical trial was used in the design of this investigation.

II. The setting for studying

This study included twenty patients with thirty joints who visited the oral and maxillofacial surgery outpatient clinic at Suez Canal University's Faculty of Dentistry. When one or both TMJs were evaluated, these patients also complained of significant clicking, restricted mouth opening, and discomfort over the TMJ region.

Employing randomization

This study was designed as a parallel-group randomized controlled clinical trial with a 1:1 allocation ratio to investigate the efficacy of injectable platelet-rich fibrin (I-PRF) versus hyaluronic acid (HA) after arthrocentesis in the treatment of temporomandibular joint internal derangement.

The operator and the participants could not be blinded due to the nature of the operations. However, an assessor who was blind to group assignment conducted radiographic and clinical evaluations after surgery.

Using the Research Randomizer Website (<https://www.randomizer.org/>), twenty patients who satisfied the inclusion criteria were divided into two equal groups at random, with ten patients in each group.

Arthrocentesis and a 2 ml injection of hyaluronic acid (HA) were administered to Group A (control).

After arthrocentesis, Group B was injected with 2 ml of Platelet-Rich Fibrin I-PRF (study).

Every patient received a thorough explanation of the surgical procedures, anticipated complications, study timetables, and images that would be used in this scientific study. After that, they completed an informed consent form.

This study was approved by the Research Ethical Committee of the Faculty of Dentistry, Suez Canal University (No. 668/2023).

Inclusion criteria:

- 1) Patients with TMJ disc displacement with or without reduction between 18 and 55 years old
- 2) Patients unresponsive to conservative treatment of TMD
- 3) Patients with limited mouth opening, painful clicking
- 4) Pain elicited with joint function

Exclusion criteria

- 1) Myofascial pain dysfunction syndrome MPDS
- 2) Patients underwent previous TMJ arthrocentesis, arthroscopy, or surgery.
- 3) Pregnancy
- 4) Patients with systemic diseases that impair soft or hard tissue healing
- 5) Patients with total joint replacement

IV- Preoperative preparation

A- All patients received a complete medical and dental evaluation, with a full medical history and examination using a standardized examination sheet including personal data, chief complaint, history of present complaint, medical history (surgery), and dental history. All patients were treated conservatively for one month, and those not responding to treatment underwent arthrocentesis.

B-To confirm the clinical diagnosis, each patient had preoperative magnetic resonance imaging (MRI). A magnetic resonance system (Achieva dStream 1.5 T; Philips Medical System, Best, The Netherlands) was used to produce static T1-weighted, T2-weighted, and proton density-weighted imaging in both open-mouth and closed-mouth postures at 1.5 Tesla. MRI was used to evaluate joint effusion, disk location and form, and bony

alterations consistent with osteoarthritis. Both coronal and sagittal sections were used to establish the disk position, which was then categorized as normal, disk displacement with reduction, or disk displacement without reduction. On T2-weighted images, joint effusion was simultaneously identified as hyperintense regions exhibiting fluid (Figure 12).

C-Preoperative measurements: The Visual Analog Scale (VAS), which ranges from 0 (no pain) to 10 (excruciating pain), was used to determine the degree of pain. Figure 1 illustrates this scale, which has 1–3 mild, 4–6 moderate, 7–9 severe, and 10 unbearable pain. Using a ruler between the incisal reference sites of the upper and lower central incisors, the maximum mouth opening, lateral mandibular movements, and protrusive movement were also measured in millimeters as indicated in Figure 2.

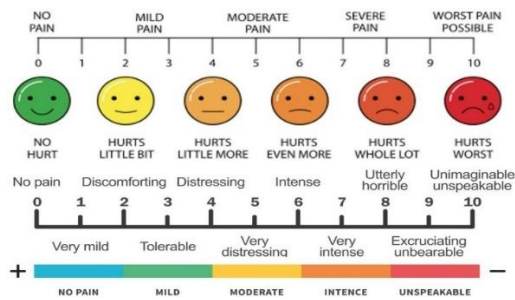


Figure 1. Visual analogue scale



Figure 2: millimeter-scale ruler measurements for clinical parameters from left to right, including maximum mouth opening, right and left mandibular movements, and protrusive movement.

V- Operative procedure:

After proper disinfection of the operative field, a cantho-tragal reference line was drawn, and an auriculotemporal nerve block was administered to ensure adequate anesthesia (Articaine HCL 4% 1:100.000 epinephrine, Artpharma pharmaceuticals, Alexandria, Egypt). Arthrocentesis was then performed using the classical two-needle Nitzan technique, with Ringer's solution. irrigation of the superior joint space. At the same time, patients were instructed to move the mandible to enhance joint lavage and release adhesions. Following arthrocentesis, 2 ml of hyaluronic acid (Hyalgan, Hyaluronic acid sodium salt, Fidia Pharmaceuticals, Italy) was injected into the superior joint space in the control group, whereas 2 ml of injectable platelet-rich fibrin (I-PRF) was administered in the study group as shown in figure 3. I-PRF was prepared immediately before the procedure by centrifuging 10 ml of venous blood without anticoagulant at 700 rpm for 3 minutes (TD4 centrifuge, Hunan Labwe Scientific Instruments, China), after which the liquid fibrin-rich upper layer was aspirated and injected intra-articularly as shown in figure4.

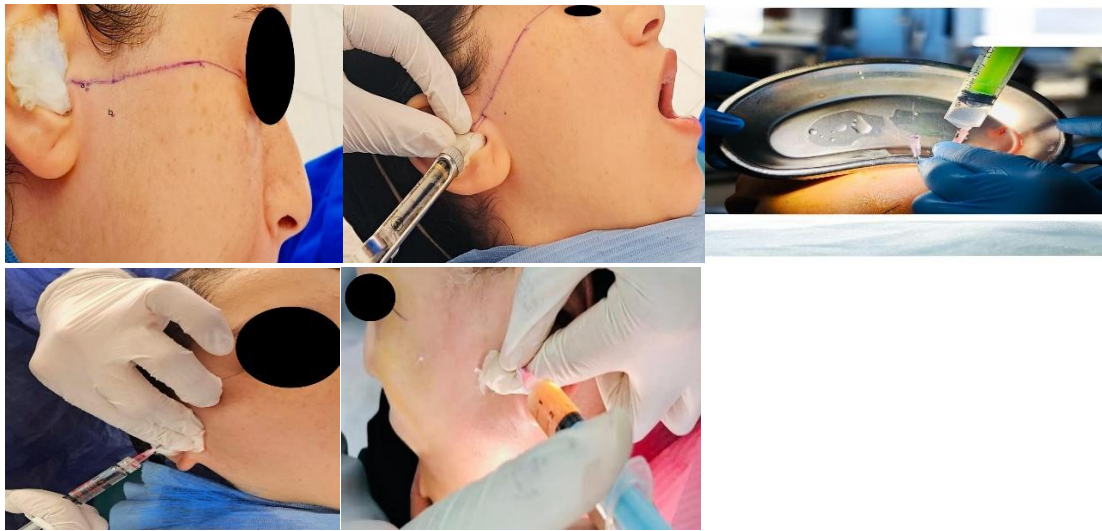


Figure 3: TMJ arthrocentesis and intraarticular injection procedure from left to right. anterior and posterior points marked along the cantho-tragal line (Hollmund-Helsing) line. auriculotemporal nerve block. joint lavage using two needle technique with Ringer's solution. intrarticular injection of 2 ml of hyaluronic acid gel (control group). intrarticular injection of 2 ml of I-PRF(study group).



Figure 4: preparation of injectable PRF. From left to right in order, collected blood into a vacuum tube without anticoagulants, centrifugation of the collected blood components showing the upper liquid I-PRF layer, and aspiration of the top liquid I-PRF layer into a syringe for intraarticular injection.

VI. Postoperative care:

Postoperatively, patients in both groups were instructed to maintain a soft diet, apply heat fomentation over the temporomandibular joint area, and perform physical exercises. Antibiotics, analgesics, and antiedematous medications were prescribed to minimize the risk of infection, control pain, and reduce edema. However, non-steroidal anti-inflammatory drugs were avoided after I-PRF injection to prevent interference with the healing process. Follow-up evaluations were conducted at 1 week, 1 month, 3 months, and 6 months to assess pain using the visual analog scale, the presence or absence of clicking, maximum mouth opening, and lateral and protrusive mandibular movements (Figure 5). In addition, a postoperative MRI was performed 6 months after surgery to evaluate changes in joint effusion and disc position (Figure 13).

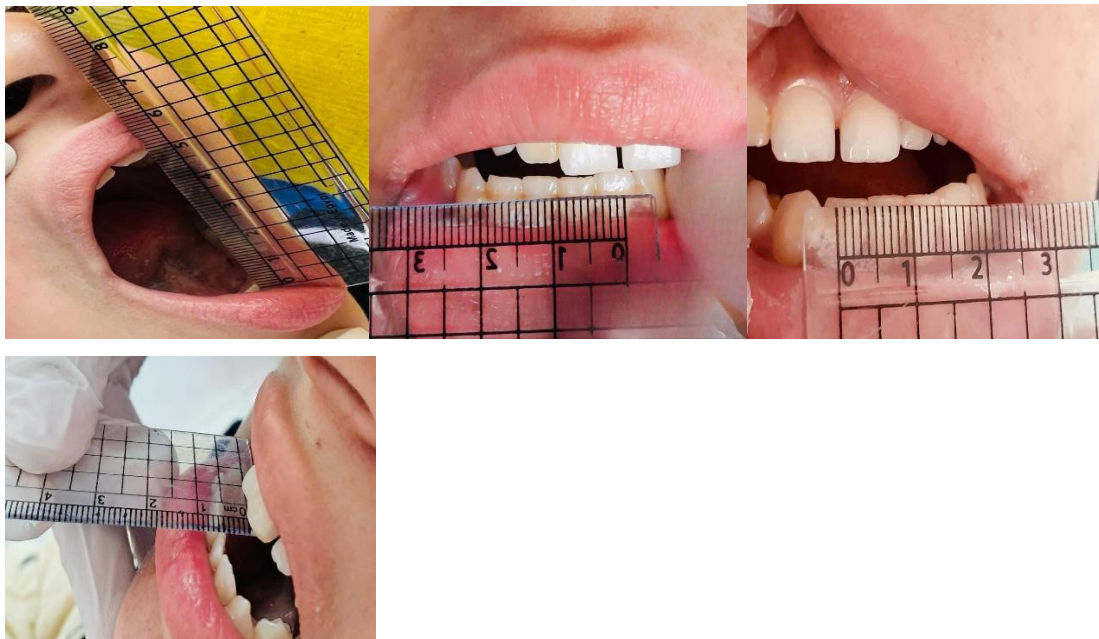


Figure 5: millimeter-scale ruler for clinical parameters at 6-month follow-up. from left to right, maximum mouth opening (MMO), right lateral movement, left lateral movement, and protrusive movement.

Outcome measures

The primary outcome of the present trial was postoperative pain reduction assessed by the visual analog scale (VAS) and maximum mouth opening, whereas joint clicking and lateral and protrusive mandibular movements were considered secondary outcomes. Clinical assessments were performed preoperatively and at 1 week, 1 month, 3 months, and 6 months postoperatively, while MRI assessment was performed preoperatively and at 6 months.

Sample size calculation

The sample size was calculated based on the expected difference in pain scores between both groups, with a significance level of 5% and a study power of 80%. The minimum required sample size was determined to provide adequate statistical power.

Statistical analysis

The following statistical tests were used to gather, compute, tabulate, and statistically evaluate all of the data. The samples were tested for normalcy using the Kolmogorov-Smirnov test. The mean $\pm$ standard deviation (SD) was used to calculate descriptive statistics. Frequencies (n) and percentages (%) will be used to display qualitative data. Groups were compared using an independent-samples t-test. Qualitative data across groups were assessed using the chi-square test. A P value of less than 0.05 is regarded as statistically significant. SPSS software for Windows version 26.0 (Statistical Package for the Social Sciences, Armonk, NY: IBM Corp.) was used for all statistical analyses, with P-values < 0.5 .

Results

This study was conducted on 20 female patients, 11 patients with bilateral joint internal derangement, while the remaining 9 patients had only one joint involved. These patients are aged from 18 to 45 years, with a mean age of 28.7 years.

This study was done to assess the following:

Maximum mouth opening

In the I-PRF group, maximum mouth opening (MMO) improved at each follow-up evaluation. The average MMO before surgery was 35.27 mm, whereas it was decreased to 41.13 mm after adjusting for 1 month ($P < 0.001$). This increase continued at 3 months (43.32 mm) and was sustained by 6 months (mean value: 43.67 mm), both of which were also statistically significant compared with preoperative values. The HA group had a mean preoperative MMO of 34.73 mm (decreased to 30.33 mm after one month with no statistical difference between measures). However, there was a clear improvement: the mean MMO of the overall cohort increased to 41.60 mm at 3 months ($p < 0.001$) and then further to 43.20 mm at 6 months ($p = 0.047$).

Both groups had nearly equidistant mean values preoperatively (35.27 mm in I-PRF, 34.73 mm in HA; $P = 0.212$). Common MMO at 1 month was significantly higher in the I-PRF group (41.13 mm) than in the HA groups (30.33 mm), although not statistically different ($P = 0.432$). Improvement was similar between the groups (I-PRF group: 42.33 mm vs. HA group: 41.60 mm; $P = 0.462$) at 3 months. At 6 months, both interventions yielded virtually identical results (mean values of 43.67 mm for I-PRF and 43.20 mm for HA), with no statistically significant difference between groups ($P = 0.296$) as shown in figure6.

Table (1): The comparison between Platelet-Rich Fibrin (PRF) and Hyaluronic Acid (HA) across different time periods for MMO

	I-PRF		HA		<i>Independent T-test</i>	<i>P value</i>
	Mean	SD	Mean	SD		
preoperative	35.27	7.30	34.73	6.43	0.212	0.833
1 month	41.13	4.84	40.33	5.29	0.432	0.669
3 months	42.33	4.20	41.60	4.48	0.462	0.648
6 months	43.67	4.08	43.20	4.55	0.296	0.770
<i>F test</i>	7.406		7.38			
<i>P value</i>	0.001**		<0.001**			

**, mean significant difference, ns mean no significant difference at $P < 0.05$

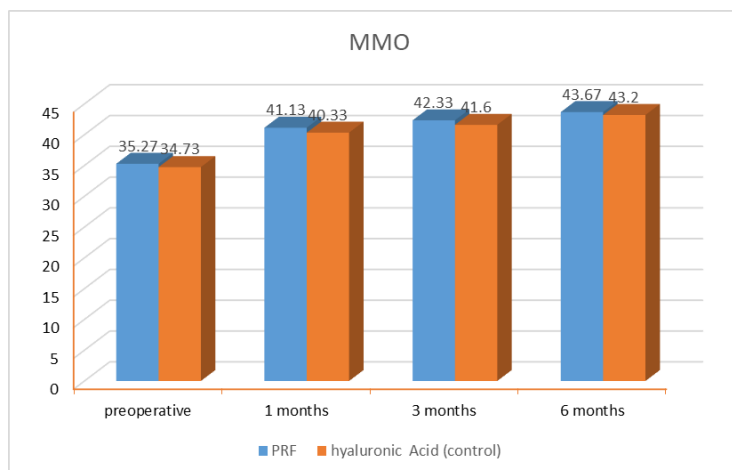


Figure 6: bar chart illustrating the mean MMO in millimeters across different follow-up intervals comparing the I-PRF and HA groups. Both groups show a statistically significant increase in MMO postoperatively compared to the baseline. But there is no statistically significant difference between them.

TMJ Pain

For pain scores, each group showed significant improvement over time postoperatively. In the I-PRF cohort, there was a statistically significant reduction in mean pain score from 7.40 preoperatively to 2.4 at 1 month, further to 1.13 at 3 months, and finally to 0.2 after 6 months of follow-up (p -value <0.001), indicating sustained statistically significant improvement (Table II). Likewise, the mean pain score in the HA group was significantly reduced from 8.13 in the preoperative period to 3.00 after 1 month, then to 1.40 after 3 months, and to 0.60 after 6 months. Comparing the two groups, the HA group had a significantly higher preoperative pain score than the I-PRF group ($P = 0.004$), and there was no statistically significant difference at 1 month ($P = 0.167$) or 3 months ($P = 0.466$). At 6 months, however, the pain score was significantly lower in the I-PRF group than in the HA group (0.20 versus 0.60, $P = 0.049$), suggesting a greater long-term effect of I-PRF on pain reduction than HA as shown in figure7.

Table (2): Comparison of PRF and HA Across Different Time Periods for Pain

	I-PRF		HA		Independent <i>T</i> -test	<i>P</i> value
	Mean	SD	Mean	SD		
preoperative	7.40	0.63	8.13	0.64	3.157	0.004**
1 month	2.40	1.30	3.00	1.00	1.42	0.167
3 months	1.13	1.13	1.40	0.83	0.739	0.466
6 months	0.20	0.41	0.60	0.63	2.049	0.049*
<i>F</i> test	75.13		75.32			
<i>P</i> value	<0.001 **		<0.001 **			

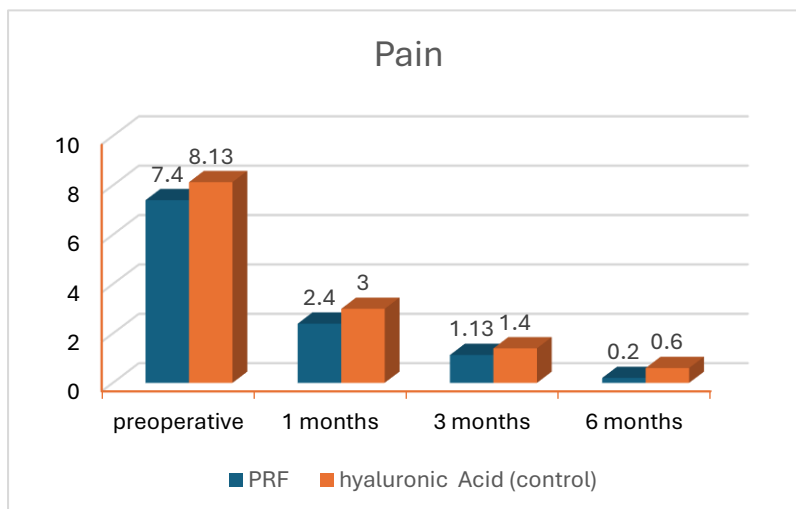


Figure 7: The bar chart illustrates a statistically significant reduction in pain in both groups across the follow-up intervals; however, the I-PRF group shows a statistically significant difference from the HA group.

TMJ clicking

Regarding TMJ clicking, both groups showed significant postoperative improvement compared with preoperative status. For the I-PRF group, preoperative clicking was found in 86.7% of patients but decreased significantly to 20% after 1 month and remained at a similar level (20%) after 3 months, then increased slightly to 26.7% after 6 months. However, it showed statistically significant improvement compared with preoperative values. All patients in the HA group presented with preoperative clicking, which decreased to 6.7% after 1 month and remained stable at 3 and 6 months. Overall, both treatments were effective in treating TMJ clicking. However, the postoperative clicking rate was lower, and long-term results were more stable in the HA group, with statistically significant differences throughout each follow-up period as shown in figure8.

Table (3): Comparison of PRF and HA Across Different Time Periods for Clicking

	I-PRF		HA		Chi square	P value
	Present (√)	Absent (X)	Present (√)	Absent (X)		
preoperative	13 (86.7%)	2 (13.3%)	15(100%)	0 (0.0%)	66.61	<0.001**
1 months	3 (20%)	12 (80%)	1 (6.7%)	14 (93.3%)		
3 months	3 (20%)	12 (80%)	1 (6.7%)	14 (93.3%)		
6 months	4 (26.7%)	11(73.3%)	1 (6.7%)	14 (93.3%)		
Chi square	19.95		46.66			
P value	0.00017**		<0.0001**			

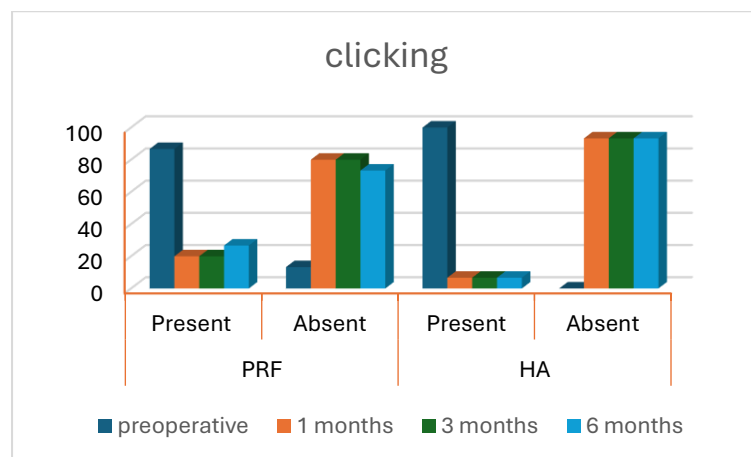


Figure 8: The bar chart demonstrates a statistically significant absence of clicking in both the I-PRF and HA groups across the follow-up intervals compared to the baseline.

Mandibular movements

Lateral mandibular movement

There was no significant improvement in left lateral mandibular movement in either the I-PRF group or the HA group during a follow-up period. In the I-PRF group, this was 8.0 mm preoperatively and remained unchanged after 1 month (7.60 mm), 3 months (7.67 mm), and finally at 6 months post-treatment (7.73 mm) (non-significant in all cases). Likewise, the mean value in the HA group was 6.73 mm at baseline, increased to 7.47 mm after 1 month, then slightly decreased to 7.13 mm after 3 months, and finally reached a value of 7.47 mm, which was not statistically significant after 6 months. No statistically significant difference in baseline or postoperative intervals was observed between the I-PRF and HA groups, suggesting that the limited effect of left lateral mandibular movement was comparable between the groups as shown in figure9.

Table (4): Comparison of PRF and HA Across Different Time Periods for Left Lateral Mandibular Movement

	I-PRF		HA		Independent T-test	P value
	Mean	SD	Mean	SD		
preoperative	8.00	3.12	6.73	3.37	1.07	0.294
1 month	7.60	1.96	7.47	2.10	0.180	0.859
3 months	7.67	2.06	7.13	2.13	0.697	0.492
6 months	7.73	1.98	7.47	1.73	0.393	0.697
F test	0.085		0.313			
P value	0.968		0.816			

**, mean significant difference, ns mean no significant difference at $P < 0.05$

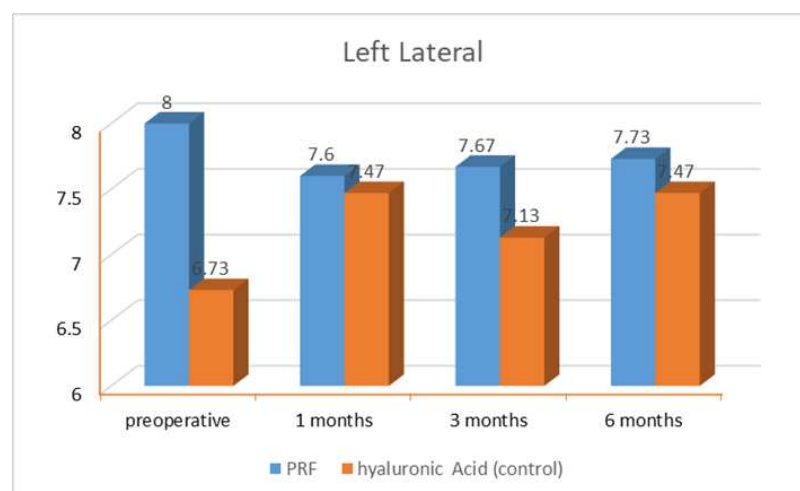


Figure 9: The bar chart illustrates the mean left lateral movement in the I-PRF and HA groups preoperatively, 1 month, 3 months, and 6 months postoperatively. No statistically significant differences were observed between the two groups across the follow-up intervals and the baseline.

Right lateral movement

Regarding right lateral mandibular movement, both the I-PRF and HA groups showed only slight postoperative changes with no statistically significant improvement over time. In the I-PRF group, the mean value was 6.87 mm preoperatively, increased slightly to 6.93 mm after 1 month, then decreased to 6.67 mm after 3 months and 6.53 mm after 6 months, with all changes being non-significant. Similarly, in the HA group, the mean value was 5.93 mm preoperatively, increased to 6.13 mm after 1 month, remained unchanged after 3 months, and reached 6.40 mm after 6 months, without a statistically significant change. Comparison between the two groups revealed no statistically significant difference at baseline or at any postoperative interval, indicating that both treatment modalities had a limited and comparable effect on right lateral mandibular movement as shown in figure10.

Table (5): Comparison between Platelet-Rich Fibrin (PRF) and Hyaluronic Acid (HA) across different times for Right Lateral Movement

	I-PRF		HA		Independent T-test	P value
	Mean	SD	Mean	SD		
preoperative	6.87	2.00	5.93	1.58	1.42	0.167
1 month	6.93	2.05	6.13	1.46	1.227	0.228
3 months	6.67	1.35	6.13	1.19	1.151	0.259
6 months	6.53	1.46	6.40	1.12	0.281	0.781
<i>F test</i>	0.167		0.302			
<i>P value</i>	0.918 ns		0.824 ns			

**, mean significant difference, ns mean no significant difference at $P < 0.05$

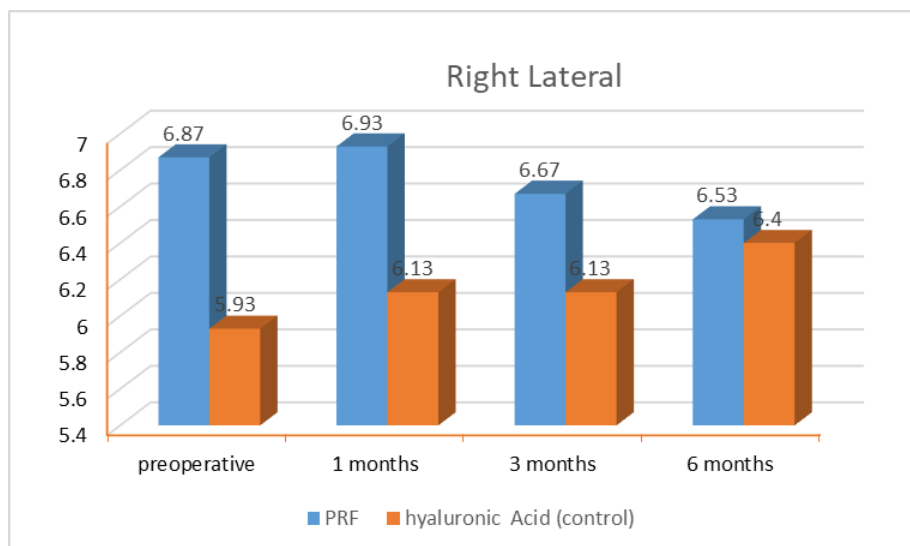


Figure 10: The bar chart illustrates no statistically significant difference in both groups across the follow-up intervals compared to the baseline.

Protrusive movement

Both groups demonstrated mild improvement in protrusive mandibular movement postoperatively with no significant change over time. In the I-PRF group, it improved from 4.27 mm preoperatively to 4.73 mm at 1 and 3 months postoperatively, then increased further to 5.07 mm at 6 months; however, there was no statistically significant difference ($p > 0.05$). In the HA group, there was also a gradual increase in the mean value from 3.47 mm preoperatively to 4.00 mm at 1 month, then to 4.13 mm after 3 months, and finally to 4.33 mm at 6 months, but this change did not reach statistical significance ($p > 0.05$). Furthermore, after comparing the two groups, the preoperative mean value in the I-PRF group was significantly higher than that in the HA group ($P = 0.039$). Still, there was no statistically significant difference between the groups at 1, 3, and 6 months, indicating that the two treatments were similar in their effects on protrusive mandibular movement over time as shown in figure 11.

Table (6): Comparison between Platelet-Rich Fibrin (PRF) and Hyaluronic Acid (HA) across different times for protrusive movement

	I-PRF		HA		Independent <i>T-test</i>	<i>P value</i>
	Mean	SD	Mean	SD		
preoperative	4.27	0.70	3.47	1.25	2.17	0.039**
1 month	4.73	0.88	4.00	0.85	2.323	0.028**
3 months	4.73	0.70	4.13	1.36	1.521	0.139
6 months	5.07	1.16	4.33	1.29	1.635	0.113
<i>F test</i>	2.077		1.43			
<i>P value</i>	0.114		0.244			

**, mean significant difference, ns mean no significant difference at $P < 0.05$

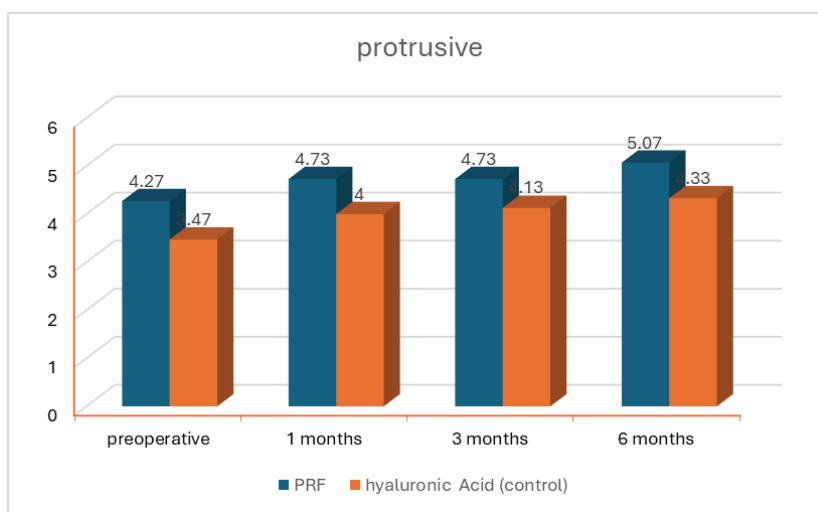


Figure 11: The bar chart illustrates the mean protrusive mandibular movement in the I-PRF and HA groups preoperatively, 1 month, 3 months, and 6 months postoperatively. Both groups showed a slight increase in protrusive range over time, with the I-PRF demonstrating slightly higher means than HA across the follow-up intervals compared to baseline.

MRI findings

1-Disc position

Regarding disc position, the comparison between the groups showed that the articular disc was anteriorly displaced in all patients preoperatively, and this finding remained unchanged at 6-month follow-up in both the I-PRF and HA groups. Similarly, evaluation within each group over time revealed no change in disc location, with the disc remaining anteriorly displaced at 1, 3, and 6 months in both groups, indicating that neither treatment modality resulted in radiographic correction of disc displacement as shown in figure12&13.

Table (7): evaluation and comparison of disc position (displacement) preoperatively and 6months postoperatively in both groups.

Time	I-PRF		HA		P values between two groups
	Yes.	No	Yes.	NO	
Preop.	10 (100%)	0 (0%)	10 (100%)	0 (0%)	>0.9999 ns
6 months	10 (100%)	0 (0%)	10 (100%)	0 (0%)	>0.999 ns
P-value within the same group	>0.999 ns		>0.999 ns		

2- Joint effusion:

Joint effusion was observed preoperatively in a significant number of patients and persisted for 6 months after the operation but disappeared in all patients in both groups. The within-group comparison showed significant improvement over time, with the I-PRF group achieving a decrease in joint effusion from 70% at baseline to 0% after 6 months, versus the HA group showing an equivalent decline where joint effusion decreased from 60% at baseline to obtaining complete absence of effusion following an identical follow-up interval, further demonstrating treatment efficacy for resolution, as both groups achieved similar results as shown in figure12&13.

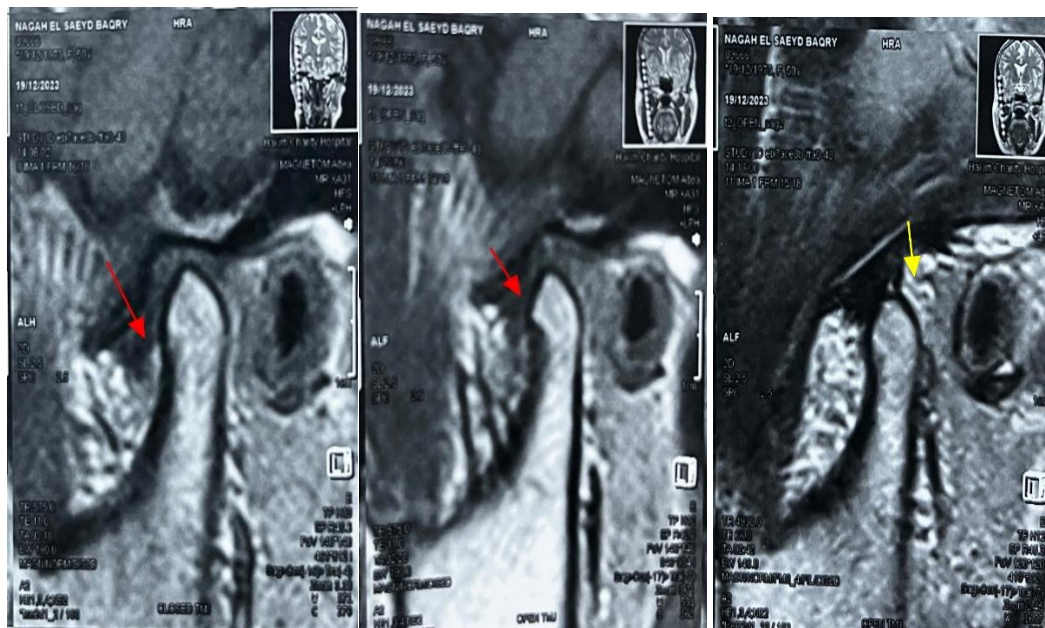


Figure 12. Preoperative sagittal MRI of the temporomandibular joint. Left (closed mouth), the red arrow shows anterior displacement of the articular disc relative to the condyle. Middle (open mouth), the red arrow shows recapture of the disc over the condyle. The yellow arrow in the right open MRI shows joint effusion.

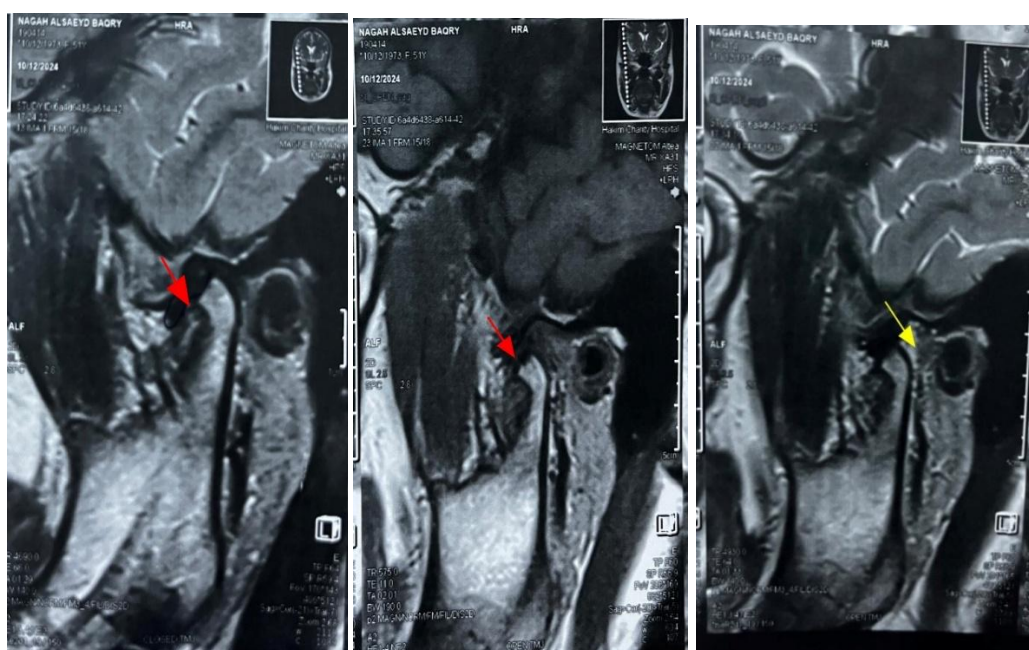


Figure 13: 6-month postoperative sagittal MRI. Left (closed mouth), the red arrow refers to the ant. Disc displacement that was recaptured over the condyle as shown in the middle. The left T2-weighted sagittal MRI illustrates the absence of joint effusion (yellow arrow).

Discussion

Several injectable materials, either with or without arthrocentesis, were utilized to restore joint lubrication when conservative treatment failed, improving joint function and the patient's quality of life. Corticosteroids, HA, and blood concentrates such as PRP and PRF are among these substances. Injectable platelet-rich fibrin and platelet-rich plasma have gained popularity recently for the treatment of various internal TMJ diseases due to their therapeutic benefits. [10]

The purpose of this study was to assess the effectiveness of injectable platelet-rich fibrin I-PRF in treating internal derangement of the temporomandibular joint. Twenty patients aged 18 to 55 with limited mouth opening due to TMJ disc displacement without reduction were the subjects of this investigation. Similarly, individuals who were refractory to conservative treatment and had disc displacement with reduction and painful clicking were also included in the study. However, the study did not include individuals who had undergone TMJ surgery, had myofascial pain dysfunction syndrome, or had systemic diseases that impair hard or soft tissue healing, such as rheumatoid arthritis. [11–16]

The study's mean patient age was 28.7 years, which is consistent with the majority of research showing that women aged 20 to 40 make up the majority of TMD patients. Guarda-Nardini et al., however, found that the average age of people with inflammatory degenerative joint illnesses is 52 years, while the average age of people with TMJ internal derangement is 32 years. [11, 12]

The superior disc space was approached using the TMJ arthroscopy technique suggested by McCain et al. The cavity for injection into the superior space is bigger than that of the inferior space. As a result, the superior space injection was employed for a considerable amount of time. [13–15] The essential point is that, due to the limited volume and concealed placement, inferior space injection was considered a difficult procedure. Even though the inferior space is small, particularly when the condyle sits beneath the fossa, it will enlarge when the mouth opens, allowing puncturing into the gap. [16]

According to Kondoh et al., there were distinct disparities between the two disc surfaces in chronic TMJ internal derangement, with the inferior surface of the articular disc exhibiting a greater frequency of morphologic alterations than the superior surface. [17–19]

In the current study, both groups showed a significant improvement in maximum mouth opening (MMO), as well as an exceptional reduction in joint pain and clicking between the baseline and six-month follow-up. These findings are consistent with those of Ghoneim et al. (2021), who reported that injection of I-PRF after arthrocentesis significantly improved MMO, discomfort, and clicking when compared to arthrocentesis alone. [20, 21]

In both the study and control groups, pain was assessed using the VAS before surgery, at one week, one month, three months, and six months. The I-PRF group experienced a statistically significant decrease in pain ($P < 0.001$) over the follow-up period. This result is in line with a prospective study by Mustafa Manafikhi et al., which found that three intra-articular injections of I-PRF, spaced one week apart, significantly reduced pain. [25] Additionally, a systematic evaluation headed by Bousnaki et al. found that intra-articular PRP injections after arthrocentesis or arthroscopy significantly reduced pain. [26] Additionally, during the current trial's observation period, I-PRF outperformed HA in reducing pain, and this difference was statistically significant at the six-month follow-up ($P = 0.001$). Hegab et al. conducted a single-blinded RCT with two groups. Following arthrocentesis, group 1 received three intra-articular injections of PRP using 50 milliliters of Ringer's lactate, while group 2 received three intra-articular injections of HA using 50 milliliters of Ringer's lactate. They concluded that PRP was better in treating TMJOA than HA [27, 28].

Maximum mouth opening was assessed in the study group before surgery, on day seven, one month, three months, and six months thereafter. The mean values at these intervals showed a statistically significant difference over time ($P = 0.001$). Similarly, during the six-month follow-up, the control group's mouth opening increased over time and was statistically significant ($P < 0.001$). This is probably because hyaluronic acid has a lubricating effect,

allowing joints to move more smoothly. Mahmoud Toamah et al. also noted this, reporting a notable increase in mouth opening following HA injection compared with arthrocentesis alone. [22] Over the follow-up period, I-PRF did not demonstrate greater improvement in MMO than HA. Since $P > 0.001$, there was no statistically significant difference between them. This result is consistent with an RCT by Comert et al., which found that PRP injection was not superior to HA injection for the treatment of OA patients after arthrocentesis. [23]

The study group's lateral and protrusive joint movements were assessed before surgery, one week, one month, three months, and six months thereafter. However, there was no discernible change over time ($P > 0.001$). This result was in contrast to Ghoneim et al.'s findings, which showed a statistically significant difference in lateral joint motions across the follow-up intervals following I-PRF injection as opposed to arthrocentesis alone. [20-26]

While the trial demonstrated comparable overall efficacy between treatment groups, statistical analysis indicated superior reduction of joint clicking in the hyaluronic acid group compared to the I-PRF group. This apparent discrepancy may be attributed to baseline differences; patients presenting with a closed lock lacked clicking at baseline. Following arthrocentesis and I-PRF injection, the restoration of joint lubrication and disc mobility led to the return of joint clicking at six months, thereby skewing the comparative analysis for this parameter. [20] Likewise, there was a significant decrease in joint sounds in the HA group ($P < 0.001$). This could be attributed to the visco supplementation provided by HA, which increases joint lubrication and enhances the smooth movement of the condyle disc complex.

Except for the elimination of any joint effusion, which was associated with decreased discomfort and increased mouth opening, the MRI results were not good overall, despite favorable clinical results in terms of increased mouth opening, reduced pain, and decreased clicking.

The disc location did not change at the six-month postoperative MRI in this investigation. This is consistent with the findings of Sato et al., who found that although disc deformity and displacement persisted, the patients' clinical complaints improved and their range of motion for maximal mouth opening increased over the course of the follow-up period, which lasted up to 12 months. [29] Accordingly, even when disc deformity and displacement persist, injecting sodium hyaluronate into the superior joint area may reduce discomfort and enhance the mouth-opening range of motion. [30-35] Larhiem et al. have shown that small changes in patient positioning, muscle tone, or joint effusion can frequently mask subtle changes in disc alignment on serial magnetic resonance imaging (MRI), making it difficult to detect small improvements reliably. [36]

This study had some limitations, including the relatively small sample size, the short follow-up period, and the inclusion of female patients only, which may limit the generalizability of the findings. In addition, the discrepancy between the number of patients and affected joints may have influenced data interpretation.

Conclusion

The study's findings demonstrated that I-PRF is useful for treating TMJ internal derangement, including discomfort, clicking, and mouth opening. It, however, did not outperform the hyaluronic acid-treated control group.

Recommendations

For the treatment of TMJ internal derangement, I-PRF is advised as a safe, hypoallergenic, and efficient intra-articular injection. To assess any potential negative effects of using I-PRF, more testing with larger samples and longer follow-up periods is advised.

Declarations:

- **Ethical approval:**

This study was performed in line with the principles of the declaration of Helsinki. Approval was granted by the Research Ethics Committee of the faculty of Dentistry, Suez Canal University (approval no. 668/2023)

- **Consent to participants:**

Written informed consent was obtained from all individual participants included in the study.

- **Funding:**

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

References

1. Vingender S, Döri F, Schmidt P, Hermann P, Vaszilko MT (2023) Evaluation of the efficiency of hyaluronic acid, PRP, and I-PRF intra-articular injections in the treatment of internal derangement of the temporomandibular joint: a prospective study. *J Craniomaxillofac Surg* 51(1):1–6.
2. Dimitroulis G (2018) Management of temporomandibular joint disorders: a surgeon's perspective. *Aust Dent J* 63:S79–S90.
3. Stegenga B, de Bont LG, van der Kuijl B, Boering G (1992) Classification of temporomandibular joint osteoarthritis and internal derangement. Part I: diagnostic significance of clinical and radiographic symptoms and signs. *Cranio* 10(2):96–106.
4. Park JW, Jeong WG, Lee JE, Lee HJ, Ki SY, Lee BC, Kim HO, Kim SK, Heo SH, Lim HS, Shin SS (2020) Pictorial review of mediastinal masses with an emphasis on magnetic resonance imaging. *Korean J Radiol* 22(1):139.
5. Harba AN, Harfoush M (2021) Evaluation of the participation of hyaluronic acid with platelet-rich plasma in the treatment of temporomandibular joint disorders. *Dent Med Probl* 58(1):81–88.
6. Xu J, Ren H, Zhao S, Li Q, Li C, Bao G, Kang H (2023) Comparative effectiveness of hyaluronic acid, platelet-rich plasma, and platelet-rich fibrin in treating temporomandibular disorders: a systematic review and network meta-analysis. *Head Face Med* 19(1):39.
7. Abd El Raouf M, Wang X, Miusi S, Chai J, Mohamed Abdel-Aal AB, Nefissa Helmy MM, Ghanaati S, Choukroun J, Choukroun E, Zhang Y, Miron RJ (2019) Injectable-platelet-rich fibrin using the low-speed centrifugation concept improves cartilage regeneration when compared to platelet-rich plasma. *Platelets* 30(2):213–221.
8. Marx RE, Carlson ER, Eichstaedt RM, Schimmele SR, Strauss JE, Georgeff KR (1998) Platelet-rich plasma: growth factor enhancement for bone grafts. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 85(6):638–646.
9. Choukroun J, Ghanaati S (2018) Reduction of relative centrifugation force within injectable platelet-rich-fibrin (PRF) concentrates advances patients' own inflammatory cells, platelets, and growth factors: the first introduction to the low-speed centrifugation concept. *Eur J Trauma Emerg Surg* 44:87–95.
10. Ujin Yap A, Cao Y, Zhang MJ, Lei J, Fu KY (2021) Age-related differences in diagnostic categories, psychological states, and oral health-related quality of life of adult temporomandibular disorder patients. *J Oral Rehabil* 48(4):361–368.

11. Okeson JP (2015) Temporomandibular disorders: etiology and classification. *TMD Orthodontics* 19–36.
12. Bagis B, Ayaz EA, Turgut S, Durkan R, Özcan M (2012) Gender difference in prevalence of signs and symptoms of temporomandibular joint disorders: a retrospective study on 243 consecutive patients. *Int J Med Sci* 9(7):539.
13. Guarda-Nardini L, Piccotti F, Mogno G, Favero L, Manfredini D (2012) Age-related differences in temporomandibular disorder diagnoses. *Cranio* 30(2):103–109.
14. Yap AU, Cao Y, Zhang MJ, Lei J, Fu KY (2021) Age-related differences in diagnostic categories, psychological states, and oral health-related quality of life of adult temporomandibular disorder patients. *J Oral Rehabil* 48(4):361–368.
15. Dimitroulis G, Dolwick MF, Martinez A (1995) Temporomandibular joint arthrocentesis and lavage for the treatment of closed lock: a follow-up study. *Br J Oral Maxillofac Surg* 33(1):23–27.
16. Chęciński M, Chęcińska K, Turosz N, Sikora M, Chlubek D (2023) Intra-articular injections into the inferior versus superior compartment of the temporomandibular joint: a systematic review and meta-analysis. *J Clin Med* 12(4):1664.
17. Li C, Zhang Y, Lv J, Shi Z (2012) Inferior or double joint space injection versus superior joint space injection for temporomandibular disorders: a systematic review and meta-analysis. *J Oral Maxillofac Surg* 70(1):37–44.
18. Kondoh T, Westesson PL, Takahashi T, Seto KI (1998) Prevalence of morphological changes in the surfaces of the temporomandibular joint disc associated with internal derangement. *J Oral Maxillofac Surg* 56(3):339–343.
19. Park JW, Song HH, Roh HS, Kim YK, Lee JY (2012) Correlation between clinical diagnosis based on RDC/TMD and MRI findings of TMJ internal derangement. *Int J Oral Maxillofac Surg* 41(1):103–108.
20. Wurm MC, Behrends TK, Wüst W, Wiesmüller M, Wilkerling A, Neukam FW, Schlittenbauer T (2018) Correlation between pain and MRI findings in TMD patients. *J Craniomaxillofac Surg* 46(8):1167–1171.
21. Ghoneim NI, Mansour NA, Elmaghraby SA, Abdelsamea SE (2022) Treatment of temporomandibular joint disc displacement using arthrocentesis combined with injectable platelet-rich fibrin versus arthrocentesis alone. *J Dent Sci* 17(1):468–475.
22. Sielski M, Chęcińska K, Chęciński M, Sikora M (2023) Injectable platelet-rich fibrin (I-PRF) administered to temporomandibular joint cavities: a scoping review. *J Clin Med* 12(9):3326.
23. Toameh MH, Alkhouri I, Karman MA (2019) Management of patients with disk displacement without reduction of the temporomandibular joint by arthrocentesis alone, plus hyaluronic acid or plus platelet-rich plasma. *Dent Med Probl* 56(3):265–272.
24. Kiliç SC, Güngörmüş M (2016) Is arthrocentesis plus platelet-rich plasma superior to arthrocentesis plus hyaluronic acid for the treatment of temporomandibular joint osteoarthritis: a randomized clinical trial. *Int J Oral Maxillofac Surg* 45(12):1538–1544.
25. Korkmaz YT, Altıntaş NY, Korkmaz FM, Candırlı C, Coskun U, Durmuslar MC (2016). Is hyaluronic acid injection effective for the treatment of temporomandibular joint disc displacement with reduction? *J Oral Maxillofac Surg* 74(9):1728–1740.
26. Manafikhi M, Ataya J, Heshmeh O (2022) Evaluation of the efficacy of platelet-rich fibrin (I-PRF) intra-articular injections in the management of internal derangements of temporomandibular joints—a controlled preliminary prospective clinical study. *BMC Musculoskelet Disord* 23(1):454.
27. Bousnaki M, Bakopoulou A, Koidis P (2018) Platelet-rich plasma for the therapeutic management of temporomandibular joint disorders: a systematic review. *Int J Oral Maxillofac Surg* 47(2):188–198.

28. Guarda-Nardini L, Stifano M, Brombin C, Salmaso L, Manfredini D (2007) A one-year case series of arthrocentesis with hyaluronic acid injections for temporomandibular joint osteoarthritis. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 103(6):e14–e22.
29. Hegab AF, Ali HE, Elmasry M, Khallaf MG (2015) Platelet-rich plasma injection as an effective treatment for temporomandibular joint osteoarthritis. *J Oral Maxillofac Surg* 73(9):1706–1713.
30. Sato S, Sakamoto M, Kawamura H, Motegi K (1999) Disc position and morphology in patients with nonreducing disc displacement treated by injection of sodium hyaluronate. *Int J Oral Maxillofac Surg* 28(4):253–257.
31. Long X, Chen G, Cheng AH, Cheng Y, Deng M, Cai H, Meng Q (2009) A randomized controlled trial of superior and inferior temporomandibular joint space injection with hyaluronic acid in treatment of anterior disc displacement without reduction. *J Oral Maxillofac Surg* 67(2):357–361.
32. Saad KA (2017). Intra-articular injection of hyaluronic acid alone in comparison with hyaluronic acid and PRP in the treatment of internal derangement of the temporomandibular joint. *Egypt Dent J* 63(4):3113–3124.
33. Sanromán JF, Ferro MF, López AC, Bua JA, López A (2016) Does injection of plasma rich in growth factors after temporomandibular joint arthroscopy improve outcomes in patients with Wilkes stage IV internal derangement? A randomized prospective clinical study. *Int J Oral Maxillofac Surg* 45(7):828–835.
34. Larheim TA, Katzberg RW, Westesson PL, Tallents RH, Moss ME (2001) MR evidence of temporomandibular joint fluid and condyle marrow alterations: occurrence in asymptomatic volunteers and symptomatic patients. *Int J Oral Maxillofac Surg* 30(2):113–117.