

Effectiveness of Arthrocentesis Combined with Occlusal Splint Therapy for Temporomandibular Joint Disorders: A Systematic Review and Meta-analysis

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ABSTRACT

Aim: To evaluate the effectiveness of arthrocentesis combined with occlusal splint therapy, compared with arthrocentesis alone or control interventions, in patients with temporomandibular joint disorders (TMDs), focusing on pain reduction and improvement in mandibular function.

Materials and Methods: A systematic review and meta-analysis was conducted in accordance with PRISMA 2020 and registered in PROSPERO. Electronic databases were searched for randomized controlled trials, prospective studies, and retrospective studies published from January 2000 to December 2024. Eligible studies included patients with TMDs who received arthrocentesis with occlusal splints, and compared outcomes against arthrocentesis alone or control interventions. Outcomes assessed were pain (including VAS where reported), maximum mouth opening (MMO), protrusive movements, and lateral excursive movements. Risk of bias was evaluated using the Cochrane ROB-2 tool. A random-effects meta-analysis was performed using standardized mean difference (SMD) as the effect estimate, and publication bias was assessed using funnel plot analysis.

Results: Nine studies were included in the qualitative synthesis, and six were included in the meta-analysis. Overall, the included studies showed low risk of bias. Pooled analysis demonstrated greater pain reduction in the arthrocentesis plus occlusal splint group at 1, 3, and 6 months compared with arthrocentesis alone, though these between-group differences were not statistically significant. Improvements in MMO and mandibular movements (protrusive and lateral excursions) were consistently higher with combined therapy. Longitudinal analysis from baseline to 6 months showed statistically significant reductions in pain and significant increases in MMO ($p < 0.001$). Funnel plot assessment did not suggest publication bias.

Conclusion: Arthrocentesis combined with occlusal splint therapy appears to provide sustained pain relief and functional improvement in patients with TMDs and may be considered a reliable, minimally invasive treatment approach. However, further high-quality randomized controlled trials using standardized treatment protocols and longer follow-up are needed to confirm the magnitude and durability of benefit.

Keywords: Arthrocentesis; Mandibular movements; Mouth opening; Occlusal splints; Pain; Temporomandibular joint disorders.

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Introduction

Temporomandibular joint disorders (TMDs) represent a heterogeneous group of musculoskeletal and intra-articular conditions affecting the temporomandibular joint (TMJ), masticatory muscles, and associated structures [1]. They are among the most common causes of non-odontogenic orofacial pain and functional limitation, with a higher prevalence in young and middle-aged adults, particularly females [1]. Clinically, TMDs manifest as joint pain, restricted mandibular movements, joint sounds, and impaired quality of life. Among these conditions, internal derangement of the TMJ—especially disc displacement with or without reduction—constitutes a major pathological subset contributing to chronic pain and dysfunction [1].

Disc displacement without reduction (DDWoR), often presenting as a closed-lock condition, is considered an advanced form of internal derangement [2]. It is characterized by a non-reducing displaced articular disc that mechanically obstructs normal condylar translation, resulting in restricted mouth opening, pain during mandibular function, and progressive degenerative joint changes if left untreated. Magnetic resonance imaging (MRI) remains the diagnostic gold standard for identifying disc position, inflammatory changes, and associated osseous alterations [3].

Management of TMDs traditionally follows a stepwise approach, beginning with conservative modalities such as pharmacotherapy, physiotherapy, and occlusal splint therapy [3]. Occlusal splints are widely used to reduce abnormal occlusal loading, decrease intra-articular pressure, relax masticatory muscles, and redistribute functional forces within the TMJ [1]. Although splint therapy has demonstrated effectiveness in alleviating pain and improving function, its success often depends on prolonged use and patient compliance, and outcomes may be suboptimal in cases with significant intra-articular pathology or inflammatory changes [4]. Arthrocentesis, first introduced as a minimally invasive surgical procedure, has emerged as an effective intervention for TMJ internal derangement unresponsive to conservative therapy [5]. The procedure involves lavage of the superior joint space, leading to mechanical lysis of adhesions, reduction of intra-articular pressure, and elimination of inflammatory mediators such as prostaglandins and cytokines [6]. Numerous clinical studies have reported significant improvements in pain reduction and

mandibular mobility following arthrocentesis, with success rates ranging from 70% to 90% and minimal associated morbidity [7].

However, arthrocentesis alone does not address ongoing mechanical stress or parafunctional habits that contribute to disease progression [8]. This limitation has led to increasing interest in combined treatment strategies. The adjunctive use of occlusal splints following arthrocentesis has been proposed to stabilize the joint, maintain therapeutic gains, and prevent recurrence by controlling occlusal forces and parafunctional activity [8]. Several prospective and retrospective studies have demonstrated that the combination of arthrocentesis with stabilization or repositioning splints results in superior and more sustained improvements in pain scores, maximum mouth opening, and overall joint function compared to either modality alone [9].

Comparative clinical trials further suggest that patients receiving combined therapy experience faster symptom resolution, better long-term functional outcomes, and reduced relapse rates, particularly in cases of acute or chronic closed lock, bruxism-associated TMDs, and internal derangement with erosive bony changes [10-13]. Despite these encouraging findings, the literature remains heterogeneous with respect to study design, patient selection, splint type, follow-up duration, and outcome measures, leading to variability in reported effectiveness [14,15].

Given the growing body of evidence supporting combined arthrocentesis and occlusal splint therapy, yet the absence of consensus regarding its magnitude of benefit over standalone treatments, a systematic synthesis of available data is warranted. Therefore, the present systematic review and meta-analysis aims to critically evaluate and quantitatively assess the effectiveness of arthrocentesis combined with occlusal splints in patients with temporomandibular joint disorders, focusing on pain reduction, improvement in mandibular function, and overall clinical outcomes.

Methodology

Protocol development

This review was carried out according to preferred reporting items for systematic review (PRISMA) 2020 checklist [16] and registered in PROSPERO-CRD40202643265.

Study design

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Focused research question in the Participants (P), Intervention (I), Comparison (C) and Outcome (O) format was proposed “What is the effect of arthrocentesis combined with occlusal splints in patients with temporomandibular joint disorders?”

P – patients with temporomandibular joint disorders (TMDs)

I – arthrocentesis with occlusal splints

C – arthrocentesis without occlusal splints / placebo or control treatment

O – pain, maximum mouth opening (MMO), protrusive movements (PM), right lateral excursion movements (RLM) and left lateral excursion movements.

Eligibility Criteria:

a) Inclusion Criteria:

- 1) Studies published in English language
- 2) Studies involving patients with TMD below 18 years
- 3) Studies published from January 2000 – December 2024 and from open access journals
- 4) Studies having sufficient data on effectiveness of arthrocentesis with occlusal splints in patients with TMD
- 5) Studies reporting study outcomes as reduction in pain, improved mouth opening (MMO), protrusive movements (PM), right lateral excursion movements (RLM) and left lateral excursion movements.
- 6) Randomized controlled trial (RCT), retrospective and prospective studies were selected

b) Exclusion Criteria:

- 1) Any studies conducted before 2000
- 2) Articles in other than English language
- 3) reviews, abstracts, letter to the editor, editorials, animal studies and in vitro studies were excluded
- 4) Articles not from open access journals

Search Strategy

Database search was performed till December 2024 for studies published within the last 24 years: PubMed, google scholar and EBSCOhost. Key words and Medical Subject Heading (MeSH) terms were selected and combined with Boolean operators like AND/OR as shown in **table 1**.

	Strategy
Population	"Temporomandibular joint"[MeSH Terms] OR " Temporomandibular joint disorders" OR "internal derangement" OR ("disc displacement with/without reduction"[MeSH Terms] OR "acute AND chronic closed lock" OR "erosive bone changes"

Intervention	("Arthrocentesis"[MeSH Terms] AND ("occlusal splints" AND "stabilizing splints" AND "anterior repositioning splints" OR "centric splints" OR "distraction splints" AND "Temporomandibular joint"[MeSH Terms] OR " Temporomandibular joint disorders" OR "internal derangement" OR ("disc displacement with/without reduction"[MeSH Terms] OR "acute AND chronic closed lock" OR "erosive bone changes".
Comparator	"Arthrocentesis" OR "lavage"[MeSH Terms] OR ("i-PRF" OR "placebo treatmet" OR "control group" AND "Temporomandibular joint"[MeSH Terms] OR " Temporomandibular joint disorders" OR "internal derangement" OR ("disc displacement with/without reduction"[MeSH Terms] OR "acute AND chronic closed lock" OR "erosive bone changes".
Outcome assessed	("pain"[MeSH Terms] AND "maximum mouth opening" AND ("protrusive movements"[MeSH Terms] AND ("right lateral excursion") AND "left lateral excursion" AND "joint sound" AND "joint clicking" AND ("retrospective study") AND "randomized controlled trial" AND "prospective study")

Table 1: search strategy table

Screening Process

A rigorous two-phase screening process was conducted by two authors to select relevant articles. Initially, titles and abstracts were reviewed, and non-relevant articles were excluded. Same reviewers independently performed the review of full text articles, with disputes resolved through discussion. A third reviewer was consulted when necessary to ensure consensus.

Data extraction

For included studies, descriptive data was extracted under following heading: author(s), country of study, year of study, sample size (mean age), TMD evaluated, modalities used, parameters assessed, follow up duration and conclusion.

Quality assessment of studies

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Quality assessment was performed by using Cochrane collaboration risk of bias (ROB) -2 tool [17] through its various domains in Review Manager (RevMan) 5.3 software.

Statistical analysis

Statistical analysis was performed with standardized mean difference (SMD) serving as the summary measure. Significance was determined at the threshold of $p < 0.05$ [18].

Assessment of heterogeneity

The Cochran's test for heterogeneity was employed to assess the significance of any differences in treatment effect estimations among trials. Heterogeneity was deemed statistically significant if the P-value was < 0.01 [19].

Investigation of publication bias

The study assessed publication bias using Begg's funnel plot, which plots the effect size against standard error. Asymmetry in the funnel plot may indicate potential publication bias [20].

Results

Study Selection

After database search (n=250), duplicates removal and putting all inclusion and exclusion criteria's, in the end nine studies were included in for qualitative as well as quantitative synthesis as illustrated in **Figure 1**.

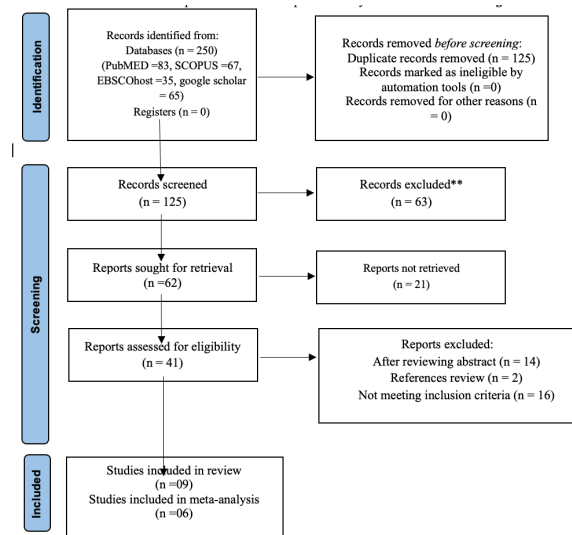


Figure 1. PRISMA 2020 Flow Diagram

Author, years of study	Country	Sample size (mean age in years)	TMD evaluated	Modalities used	Parameters assessed	Follow up duration	Conclusion
Ghanem et al., 2011 [21]	Egypt	20 (34)	Acute intermittent closed lock in	AC +/- stabilizing splints	MMO, OM, CLM and pain (VAS)	Baseline, 1,3,6,9 and 12 months	Better overall success rate and improve

Study Characteristics

As shown in **table 2** below, data was evaluated from nine studies [21-29] from an aggregate of 500 patients with various temporomandibular disorders like TMJ internal derangement, acute and chronic closed lock and anterior disc displacement with and without reduction with mean age of 34.44 years. Among the included studies, four studies [21,23,25,29] were conducted in Egypt, two studies [24,28] in Korea and one study each in Czech Republic [22], Turkey [26] and India [27]. All included studies were RCT in nature assessing and evaluating the effectiveness of arthrocentesis in combination with occlusal splints (distraction splints, centric splints or anterior repositioning splints) for management of various TMDs in terms of reduction in pain (assessed through visual analogue scale (VAS), improvement in maximum mouth opening (MMO), protrusive movements (PM), right lateral excursive movements (RLM) and left lateral excursive movements (LLM). All the parameters were assessed at an interval of at baseline, 1st month, 3rd month, 6th month, 9th month and at 12th month. From the results of the studies, it was seen that TMDs treatment with arthrocentesis with occlusal significantly reduced pain, provided adequate mandibular jaw movements with no discomfort and improved functions.

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			bruxism patients				nt was seen with AC + splint groups
Tvrđy et al., 2015 [22]	Czech Republic	144 (28)	Nonreducing TMJ disc displacement	AC +/- stabilizing splints	MMO, pain (VAS)	Baseline and 3 months	More effective results were seen with AC with splints
Osman et al., 2016 [23]	Egypt	20	TMJ ID	AC +/- occlusal bite splints	MMO, PM, pain (VAS), LLM, RLM	Baseline and 5 months	Good joint pain, adequate mandibular movements and reduced pain was observed
Heo et al., 2019 [24]	Korea	44 (34.7 ± 14.8)	Bilateral ADDwoR and erosive changes	unilateral arthrocentesis and stabilisation splint therapy	MMO, RLM, LLM, PM and pain (VAS)	Baseline and at 6 th month	Pain reduction and improved range of mandibular movements was seen with AC + splint therapy
Altaweel et al., 2021 [25]	Egypt	32 (28.02 +/- 7.18)	ADDwoR	Grp 1 – centric splint; Grp 2 – distraction splint; Grp 3: arthrocentesis + centric splint; Grp 4: arthrocentesis + distraction splint	joint function (mouth opening), joint pain through joint palpation, and pain (VAS)	preoperatively, two weeks, one month, three, and six months postoperatively	Application of arthrocentesis with occlusal splints reduced pain and improved all functions effectively.
Erdil et al. 2023 [26]	Turkey	40 (32.34 +/- 12.1)	disc displacement without reduction-induced acute and closed lock	AC + occlusal splints	MMO and pain (VAS)	Baseline and at 7 th day	Significant improvement in changes and reduction in jaw pain was seen

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Naveenatham et al., 2023 [27]	India	35 (36.6 ± 10.2)	TMJ ID	double puncture arthrocentesis and ARS	Pain (VAS), MMO and joint clicking	1 week, 2 weeks, 1,3 and 6 months	Pain reduction, improved mouth opening without discomfort was observed
Heo et al., 2024 [28]	Korea	105 (38 ± 19.3)	ID (ADDwoR and ADDwR) with erosive bone changes	before and after arthrocentesis and stabilisation splint therapy	MMO, PM, LLM, RLM and pain (VAS)	Before and after 6 months	AC + splint therapy was highly effective in pain reduction and improving mandibular movements
Nasef et al., 2023 [29]	Egypt	60	TMJ ID	Grp 1 – AC + ARS; Grp 2 – AC + ARS + i-PRF	MMO, pain (VAS), right and left lateral excursion	1 st week, 1, 3 and 6 months	Improvement in subjective and objective outcomes were observed

AC: arthrocentesis; ADDwr: anterior disc displacement with reduction; ADDwoR: anterior disc displacement without reduction; ARS: anterior repositioning splints; CLM: contralateral movements; ID: internal derangement; i-PRF: injectable platelet rich fibrin; LLM: left lateral movement; MMO: maximum mouth opening; PM: protrusive movement, RLM: right lateral movement; VAS: visual analogues scale

Table 2: showing descriptive study details of included studies

Quality assessment

The high ROB was seen for random sequence generation followed by incomplete outcome data. All of the included studies reported moderate to lowest ROB. Domains of allocation concealment, blinding of participants and personnel, blinding of outcome assessment, selective reporting and other bias were given the lowest ROB by included studies as depicted in **Figure 2 and 3**.

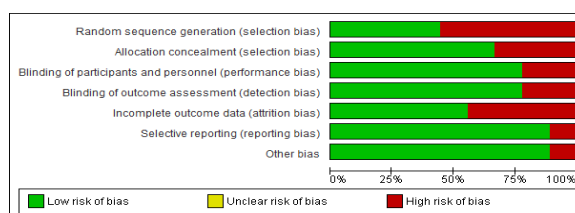


Figure 2: ROB: shown as percentages across all included studies.

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	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Altaweel et al., 2021	+	+	+	+	+	+	+
Erdil et al., 2023	-	-	+	+	+	+	+
Ghanem et al., 2011	-	+	-	+	-	+	+
Heo et al., 2019	-	+	-	+	-	+	-
Heo et al., 2024	-	+	+	+	+	+	+
Nasef et al., 2024	+	+	+	-	-	-	+
Naveenatham et al., 2023	+	+	+	+	+	+	+
Osman et al., 2016	-	-	+	-	-	+	+
Tvrdy et al., 2015	+	-	+	+	+	+	+

Figure 3: ROB summary: for each study

Synthesis of results/Meta-analysis

Effectiveness of arthrocentesis with occlusal splints were evaluated for reduction in pain, improved mouth opening (MMO), protrusive movements (PM), right lateral excursion movements (RLM) and left lateral excursion movements as shown in figures 4-13.

1. Reduction in pain (VAS)

A) Pain at 1 month (VAS)

Two studies [21,29] containing data on 50 TMD patients, of which ($n=25$) patients were evaluated by AC + occlusal splints and ($n=25$) patients by AC – occlusal splints for reduction in pain at 1 month. As shown in **Figure 4**. the SMD is -0.34 (-0.91 – 0.22) signifying that reduction in pain at 1 month on an average was -0.34 times more in AC + occlusal splints ($p>0.05$).

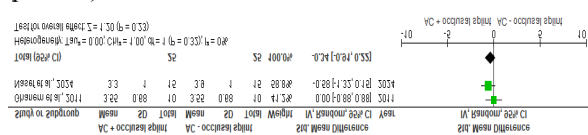
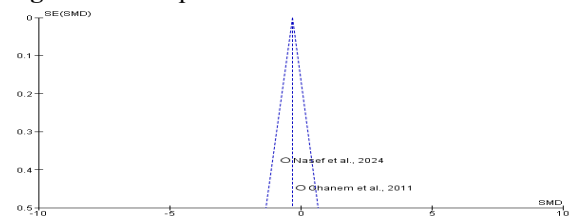


Figure 4: effect on pain reduction at 1 month



B) Pain at 3 months (VAS)

Figure 5: showing absence of publication bias

Two studies [21,29] containing data on 50 TMD patients, of which ($n=25$) patients were evaluated by AC + occlusal splints and ($n=25$) patients by AC – occlusal splints for reduction in pain at 3rd month. As shown in **Figure 6**. the SMD is -0.59 (-1.71– 0.53) signifying that reduction in pain at 3 months on an average was -0.59 times more in AC + occlusal splints ($p>0.05$).

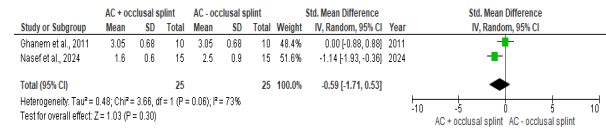


Fig 6: effect on pain at 3 months

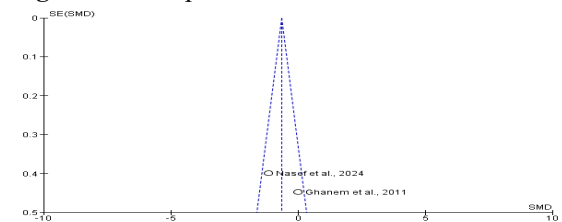


Figure 7: showing absence of publication bias

C) Pain at 6 months (VAS)

Three studies [21,23,29] containing data on 70 TMD patients, of which ($n=35$) patients were evaluated by AC + occlusal splints and ($n=35$) patients by AC – occlusal splints for reduction in pain at 3rd month. As shown in **Figure 8**. the SMD is -0.51 (-1.17– 0.15) signifying that reduction in pain at 6 months on an average was -0.51 times more in AC + occlusal splints ($p>0.05$).

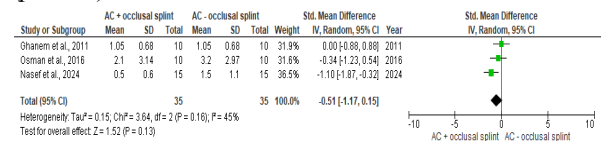


Fig 8: effect on pain at 6th month

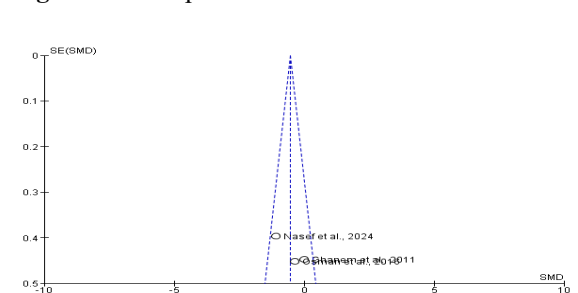


Figure 9: showing absence of publication bias

2) Maximum mouth opening (MMO)

A) MMO at 1 month

Two studies [21,29] containing data on 50 TMD patients, of which ($n=25$) patients were evaluated by AC + occlusal splints and ($n=25$) patients by AC – occlusal splints for MMO at 1 month. As shown in **Figure 10**. the SMD is 0.53 (-0.46– 1.53) signifying

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that improvement in MMO at 1 month on an average was 0.53 times more in AC + occlusal splints ($p>0.05$).

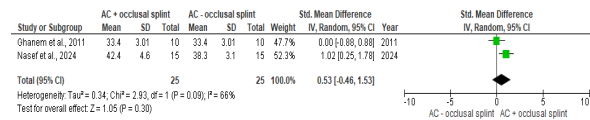


Fig 10: effect on MMO at 1st month

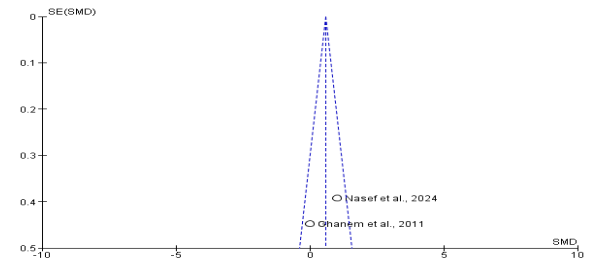


Figure 11: showing absence of publication bias

B) MMO at 3 months

Two studies [21,29] containing data on 70 TMD patients, of which ($n=35$) patients were evaluated by AC + occlusal splints and ($n=35$) patients by AC - occlusal splints for improvement in MMO at 3rd month. As shown in **Figure 12**, the SMD is (0.54 (-0.47– 1.55)) signifying that MMO improvement at 3 months on an average was 0.54 times more in AC + occlusal splints ($p>0.05$).

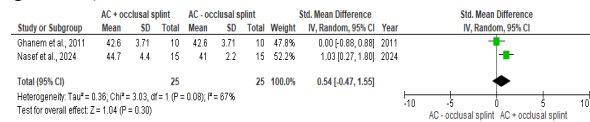


Fig 12: effect on MMO at 3rd month

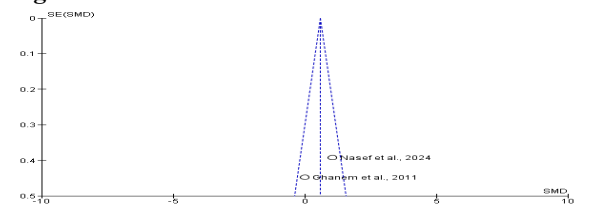


Figure 13: showing absence of publication bias

C) MMO at 6 months

Three studies [21,23,29] containing data on 70 TMD patients, of which ($n=35$) patients were evaluated by AC + occlusal splints and ($n=35$) patients by AC - occlusal splints for improvement in MMO at 6 months. As shown in **Figure 14**, the SMD is 0.66 (-0.38– 1.70) signifying that improvement in MMO at 6 months on an average was 0.66 times more in AC + occlusal splints ($p>0.05$).

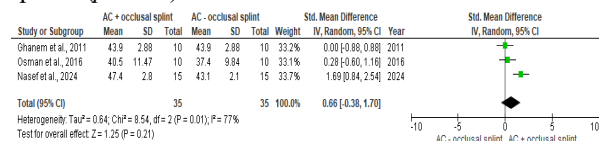


Fig 14: effect on MMO at 6th month

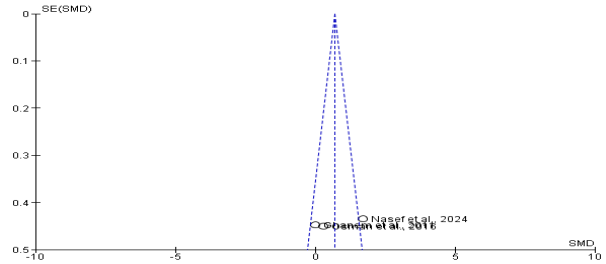


Figure 15: showing absence of publication bias

3) Protrusive movements (PM) (6 months)

Two studies [21,29] containing data on 50 TMD patients, of which ($n=25$) patients were evaluated by AC + occlusal splints and ($n=25$) patients by AC - occlusal splints for improvement in protrusive movements at 6 months. As shown in **Figure 16**, the SMD is 0.07 (-0.55– 0.69) signifying that improvement in protrusive movements at 6 months on an average was 0.07 times more in AC + occlusal splints ($p>0.05$).

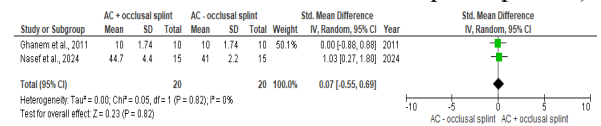


Fig 16: effect on protrusive movements at 6 months

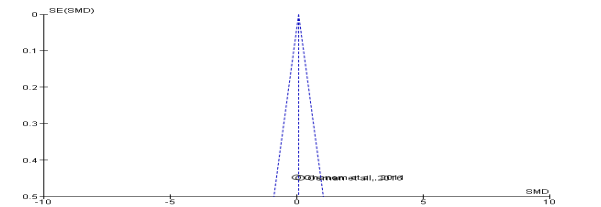


Figure 17: showing absence of publication bias

4) Right lateral excursion movements (6 months)

Two studies [21,29] containing data on 50 TMD patients, of which ($n=25$) patients were evaluated by AC + occlusal splints and ($n=25$) patients by AC - occlusal splints for right lateral excursive movements at 6 months. As shown in **Figure 18**, the SMD is 0.18 (-0.38– 0.73) signifying that right lateral excursive movements at 6 months on an average was 0.18 times more in AC + occlusal splints ($p>0.05$).

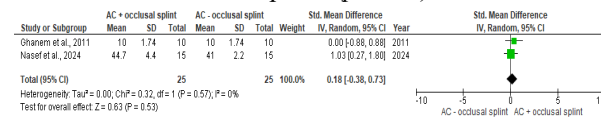


Fig 18: effect on right lateral excursive movements at 6 months

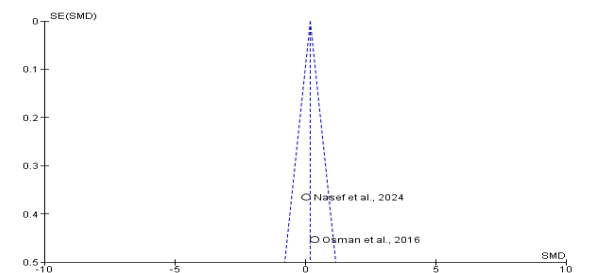


Figure 19: showing absence of publication bias

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5) Left lateral excursion movements (6 months)

Two studies [21,29] containing data on 50 TMD patients, of which ($n=25$) patients were evaluated by AC + occlusal splints and ($n=25$) patients by AC – occlusal splints for left lateral excursive movements at 6 months. As shown in **Figure 20**, the SMD is 0.23 (-0.32– 0.79) signifying that improvement in left lateral excursive movements at 6 months on an average was 0.23 times more in AC + occlusal splints ($p>0.05$).

Study or Subgroup	AC + occlusal splint			AC - occlusal splint			Weight
	Mean	SD	Total	Mean	SD	Total	
Ghanem et al., 2011	10	1.74	10	10	1.74	10	
Nasef et al., 2024	44.7	4.4	15	41	2.2	15	
Total (95% CI)			25			25	100.0%

Heterogeneity: Tau² = 0.00; Chi² = 0.03, df = 1 (P = 0.86); I² = 0%
Test for overall effect: Z = 0.82 (P = 0.41)

Fig 20: left lateral excursive movements at 6 months

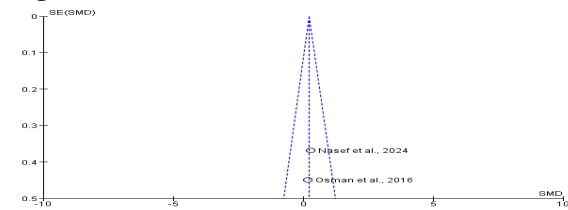


Figure 21: showing absence of publication bias

6) Overall reduction in pain (6 months)

Three studies [24,27,28] containing data on 332 with TMD, of which ($n=161$) patients were evaluated by AC + occlusal splints and ($n=161$) patients by AC – occlusal splints for overall pain reduction at 6 months post-operatively. As shown in **Figure 22**, the SMD is 1.94 (1.10– 2.78) signifying that overall pain reduction at 6 months post-operatively on an average was 1.94 times more from baseline ($p<0.05$).

Study or Subgroup	Pre-operative			Post-operative			Weight
	Mean	SD	Total	Mean	SD	Total	
Heo et al., 2019	36.8	27.5	44	6.5	14.6	44	34.1%
Navaneetham et al., 2023	5.05	0.99	35	2.08	0.91	35	30.1%
Heo et al., 2024	35.5	28.2	82	3.7	8.8	82	35.8%
Total (95% CI)			161			161	100.0%

Heterogeneity: Tau² = 0.48; Chi² = 17.97, df = 2 (P = 0.0001); I² = 89%
Test for overall effect: Z = 4.51 (P < 0.00001)

Fig 22: overall pain reduction at 6 months post-operatively

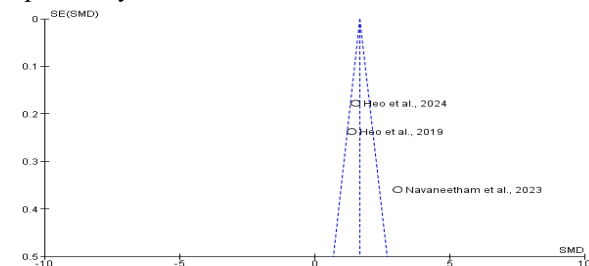


Figure 23: showing absence of publication bias

7) Overall increase in mouth opening (6 months)

Three studies [24,27,28] containing data on 332 with TMD, of which ($n=161$) patients were evaluated by AC

+ occlusal splints and ($n=161$) patients by AC – occlusal splints for overall improvement in mouth opening at 6 months post-operatively. As shown in **Figure 24**, the SMD is -1.11 (-1.40– 0.81) signifying that overall mouth opening at 6 months post-operatively on an average was 1.11 times more from baseline ($p<0.05$).

Study or Subgroup	Pre-operative			Post-operative			Weight	Std. Mean Difference IV, Random, 95% CI	Year	Std. Mean Difference IV, Random, 95% CI
	Mean	SD	Total	Mean	SD	Total				
Heo et al., 2019	37.7	7.6	44	45.6	5.9	44	30.1%	-1.15 [-1.60, -0.70]	2019	
Navaneetham et al., 2023	31.45	2.95	35	35.88	3.15	35	24.0%	-1.44 [-1.98, -0.91]	2023	
Heo et al., 2024	40.3	9.1	82	47.1	5.4	82	45.9%	-0.80 [-1.23, -0.39]	2024	
Total (95% CI)			161			161	100.0%	-1.11 [-1.40, -0.81]		

Heterogeneity: Tau² = 0.02; Chi² = 2.97, df = 2 (P = 0.23); I² = 33%
Test for overall effect: Z = 7.29 (P < 0.00001)

Fig 24: overall mouth opening improvement at 6 months post-operatively

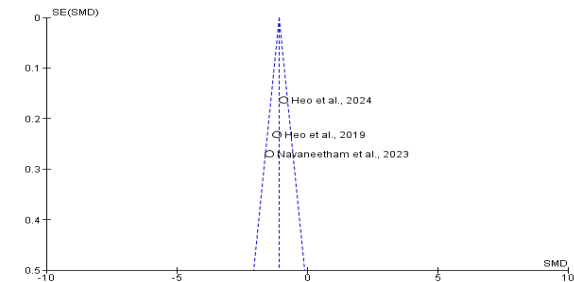


Figure 25: showing absence of publication bias

Discussion

The present systematic review and meta-analysis evaluated the effectiveness of arthrocentesis combined with occlusal splint therapy in the management of temporomandibular joint disorders (TMDs). By synthesizing evidence from nine randomized and controlled clinical studies and quantitatively analyzing six eligible trials, this review provides a comprehensive appraisal of both short-term and mid-term clinical outcomes, including pain reduction and improvement in mandibular function.

The meta-analysis demonstrated a consistent trend toward greater pain reduction in patients treated with arthrocentesis combined with occlusal splints compared to arthrocentesis alone at 1-, 3-, and 6-month follow-up intervals. Although the pooled standardized mean differences (SMDs) for pain at these time points did not reach statistical significance, the direction of effect consistently favored the combined therapy. This suggests a potential additive or synergistic benefit of splint therapy in maintaining the analgesic effects achieved by arthrocentesis.

Importantly, when pain outcomes were analyzed longitudinally from baseline to 6 months post-operatively, a statistically significant reduction in pain was observed. This finding underscores the clinical relevance of combined therapy in achieving sustained pain control rather than only short-term symptom relief. The mechanism underlying this benefit may be attributed to the dual action of arthrocentesis in reducing intra-articular inflammation and adhesions,

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coupled with the splint's ability to decrease mechanical loading, control parafunctional habits, and stabilize the joint during healing.

Functional parameters, including maximum mouth opening (MMO), protrusive movements, and lateral excursive movements, showed consistent improvement in patients receiving arthrocentesis with occlusal splints. Although intergroup comparisons between combined therapy and arthrocentesis alone did not achieve statistical significance at individual follow-up intervals, pooled estimates indicated greater functional gains with combined treatment across all evaluated outcomes.

Notably, overall improvement in MMO from baseline to 6 months was statistically significant, reflecting clinically meaningful restoration of mandibular mobility. This is particularly relevant in patients with internal derangement and closed-lock conditions, where restricted mouth opening significantly impacts mastication, speech, and quality of life. The observed functional improvements support the hypothesis that occlusal splints help preserve the mechanical benefits of arthrocentesis by minimizing recurrent joint overload and allowing adaptive remodeling of intra-articular structures.

The findings of the present review partially contrast with earlier systematic reviews³⁰⁻³² that reported no additional benefit of splint therapy following arthrocentesis. Unlike previous reviews, the present study incorporated a broader range of TMD subtypes, longer follow-up periods, and a more detailed evaluation of multiple functional outcomes beyond MMO alone. Additionally, the inclusion of recent randomized controlled trials with improved methodological quality strengthens the reliability of the present conclusions.

The apparent discrepancy between earlier null findings and the favorable trends observed in this meta-analysis may be explained by heterogeneity in splint design, duration of splint use, patient compliance, and baseline severity of TMDs. These factors likely influence treatment response and may dilute statistically significant differences when pooled across heterogeneous populations.

From a clinical perspective, the results suggest that while arthrocentesis alone is effective in reducing pain and improving joint function, the adjunctive use of occlusal splints may enhance and sustain these therapeutic effects, particularly over longer follow-up periods. Combined therapy appears especially beneficial in patients with internal derangement, closed lock, and parafunctional habits such as bruxism, where

mechanical stress plays a key role in disease persistence.

Limitations

Despite the strengths of this systematic review and meta-analysis, several limitations should be acknowledged:

Clinical heterogeneity was present among included studies with respect to TMD subtypes, splint design (stabilization, centric, distraction, or anterior repositioning splints), and duration of splint usage.

Sample sizes in individual trials were relatively small, limiting the statistical power to detect modest intergroup differences.

Follow-up duration varied across studies, with limited availability of long-term (>12 months) outcome data.

Outcome assessment tools, particularly pain scales and functional measurements, were not uniformly standardized across studies.

Although most studies demonstrated low to moderate risk of bias, blinding of participants and personnel was inherently challenging due to the nature of splint therapy, potentially introducing performance bias.

These limitations may have contributed to wide confidence intervals and imprecision in pooled estimates, warranting cautious interpretation of the results.

Future Recommendations

Future research should aim to address the existing gaps by:

Conducting large-scale, multicenter randomized controlled trials with standardized diagnostic criteria (DC/TMD) and uniform outcome measures.

Evaluating the long-term effectiveness of combined therapy with follow-up periods extending beyond one year.

Comparing different types of occlusal splints to identify the most effective design when used adjunctively with arthrocentesis.

Assessing patient-reported outcome measures, including quality of life and functional disability indices, alongside clinical parameters.

Investigating cost-effectiveness and patient compliance, which are critical for translating combined therapy into routine clinical practice.

Conclusion

This systematic review and meta-analysis indicates that arthrocentesis combined with occlusal splint therapy is an effective and minimally invasive treatment for temporomandibular joint disorders. The combined approach demonstrated consistent reductions in pain and improvements in mandibular function, with clinically meaningful benefits observed over short- and

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mid-term follow-up. Although intergroup differences were not always statistically significant at individual time points, significant improvements from baseline support the sustained therapeutic value of adjunctive splint therapy. By reducing mechanical stress and stabilizing the joint after arthrocentesis, occlusal splints may help maintain treatment gains. Further high-quality randomized controlled trials with standardized protocols and longer follow-up are required to confirm these findings and establish definitive clinical guidelines.

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Data availability: All data analysed in this systematic review are included in this published article

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