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A SYSTEMATIC REVIEW OF CLINICAL OUTCOMES IN THE TREATMENT OF TEMPOROMANDIBULAR JOINT DYSFUNCTION USING ULTRASOUND GUIDED ARTHROCENTESIS AND CONVENTIONAL THERAPY

Surgery

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ABSTRACT

Objective: This systematic review aimed to compare outcomes between ultrasound (US)-guided arthrocentesis and conventional arthrocentesis for the management of temporomandibular joint disorders (TMDs). **Methods:** PubMed, MEDLINE, Cochrane Library, Google Scholar and EBSCOhost databases were searched up to 30th September 2020 for randomized control trials (RCTs) comparing US-guided and conventional arthrocentesis. The review protocol followed the PRISMA guidelines and was registered in PROSPERO (CRD42020211942). The risk of bias of the studies was independently evaluated using Cochrane Risk of Bias tool. **Results:** Four RCTs were included. It did not demonstrate any statistically significant difference in pain or maximal mouth opening (MMO) scores after 1 week and 1 month of follow-up between US-guided and conventional arthrocentesis. Studies also reported data on intra-operative needle relocations and operating time but with conflicting results. **Conclusion:** This study indicates that the use of US during arthrocentesis may not improve postoperative pain and MMO in the short term. Further high-quality adequately powered RCTs are required to strengthen current evidence.

KEYWORDS

Ultrasonography, Arthrocentesis, Temporomandibular joint, Internal derangement, Randomised controlled trial.

INTRODUCTION

The temporomandibular joint (TMJ) is a diarthrosis, better defined as a ginglymoarthrodial joint. TMJ is composed of a synovial cavity, articular cartilage and a capsule that covers the same joint. The joint is the union of the temporal bone cavity with the mandibular condyle[1].

Temporomandibular disorder (TMD) is one the most common reasons of orofacial pain. It is a term used to describe disorders involving the temporomandibular joints (TMJs), muscles of mastication, and occlusion causing muscle or TMJ pain, reduced movement, muscle tenderness, and joint sounds.

Arthrocentesis of the temporomandibular joint (TMJ) was first described in 1991 and is regarded as a simple, minimally invasive, inexpensive, highly efficient procedure.[2]

Arthrocentesis is commonly defined as the lavage of the TMJ without viewing the joint space using sterile needles and sterile irrigants so as to reduce the pain by removing inflammatory mediators from the joint or to increase the mandibular mobility by removing intra-articular adhesions by means of hydraulic pressure from irrigation of the upper chamber of the TMJ.[3]

Conservative management is the first line of treatment for internal derangement of TMJ.[4] Arthrocentesis is generally suggested in patients irresponsive to conservative therapies.

The most important aim of TMJ arthrocentesis is to eliminate inflamed synovial fluid, release the articular disc, reduce pain, and mobilize the joint by flushing the upper joint space.[2]

Arthrocentesis of the temporomandibular joint (TMJ) can be done both conventionally and with ultrasound guidance. However, conventional techniques require experience and carry a risk of damage to collateral ligaments of the disc and adjacent soft tissue. Ultrasonography (US), one of the modalities used for imaging of the TMJ, does require expertise in interpreting the images and does not involve ionizing radiation. It is used most often for diagnosis of degenerative changes in the condyle, effusion, or disc displacement. US may also be used for intraarticular injections into the TMJ. US-guided arthrocentesis of the TMJ was first described by Daysoylu et al. and reported to be a reproducible, cost-effective method and enables correct siting and positioning of the angulation.[2,4]

MATERIAL AND METHODS

2.1) STRUCTURED REGISTRATION AND PROTOCOL

This systematic review was registered under the number CRD42020211942 in the PROSPERO database and carried out according to the PRISMA statement.

2.2) FOCUSED QUESTION

In order to perform this systematic review, the following question was elaborated:

Between ultrasound guided and conventional arthrocentesis which modality of treatment has a better efficacy in the treatment of temporomandibular joint dysfunction in the age group of 18 to 65 years?

2.3) ELIGIBILITY CRITERIA

The PICO strategy was applied in this systematic review which are essential for designing all stages of an interventional systematic review.

PICO ANALYSIS:

- (P) Types of participants: Adult human patients with age group of 18-65years diagnosed with TMD based on Wilkes Classification and where conservative therapy failed/ did not give any relief.
- (I) Types of interventions: TMJ dysfunction with Ultrasound guided arthrocentesis and conventional arthrocentesis.
- (C) Comparison between interventions: All possible comparisons between US guided with conventional arthrocentesis in the treatment of TMJ Dysfunction.
- (O) Type of outcomes measures: Primary outcomes: Interincisal mouth opening, Number of attempts of the needle prick, Pain on VAS, Lateral and protrusive excursion.
- (S) Types of studies: Only randomized controlled clinical trials (RCTs) were considered.

Additionally,

The following additional inclusion criteria were considered:

- RCTs, with or without a split mouth design comparing the results of atleast 1 of the clinical outcome in patients with TMD
- with Wilkes Stage 1, 2 or higher
- with TMJ Dysfunction
- Only studies published in English were considered.

In this SR, the following items were considered as exclusion criteria:

- RCTs comparing variations of a same technique (i.e. arthrocentesis with Arthroscopy or arthrocentesis with conventional medication therapy)
- with unclear data on Wilkes Classification
- considering patients with previous surgery for TMJ

- evaluating data on pregnancy or medically compromised patients.
- Case reports, descriptive studies, review articles, editorial letters, conferences, book chapters, abstract's opinion articles, animal studies, insufficient information and *in vitro* studies were not considered

2.4) INFORMATION SOURCE AND LITERATURE SEARCH:

For the identification of randomised clinical trials to be considered for inclusion in this systematic review, PubMed, MEDLINE, Cochrane Library, Google Scholar AND EBSCOhost were employed as electronic databases.

Last electronic search was carried out on 30 September 2020.

Following search terms alone and in combination were used by means of PUBMED search builder:

(US[All Fields] AND guided[All Fields] AND ("arthrocentesis"[MeSH Terms] OR "arthrocentesis"[All Fields])) AND (Conventional [All Fields] AND ("arthrocentesis"[MeSH Terms] OR "arthrocentesis"[All Fields])) AND ("temporomandibular joint"[MeSH Terms] OR ("temporomandibular"[All Fields] AND "joint"[All Fields]) OR "temporomandibular joint"[All Fields]) AND ("randomized controlled trial"[All Fields] OR "randomized controlled trials as topic"[MeSH Terms] OR "randomised controlled trial"[All Fields] OR "randomized controlled trial"[All Fields])

No Limits and language restrictions were applied during the electronic search to include all the possible clinical trials in the potentially relevant article search phase of the systematic review. Reference list of the reviews and of the identified randomized trials were also checked for possible additional studies. The article search was then narrowed down manually by the reviewer according to the inclusion criteria of the present systematic review to include all the RCTs in English language only and the articles involving treatment of intra bony defects.

Additionally, hand search was also carried out in all relevant journals up to and including June 2020.

Journals Included for Hand Search: · International Journal of Oral & Maxillofacial Surgery British Journal of Oral & Maxillofacial Surgery Journal of Oral & Maxillofacial Surgery

2.5) STUDY SELECTION:

Study selection was conducted by independent reviewers in the following stages:

Initial screening of potentially-suitable titles and abstracts against the inclusion criteria to identify potentially relevant papers. Before initial screening, all the items found through electronic and manual searches were grouped into a single list, excluding duplicates. Independent screening of the titles and abstracts (when available) of all reports identified. When studies met the inclusion criteria or when insufficient data from abstracts for evaluating inclusion criteria were gained, full article was obtained. Full text articles which met the inclusion criteria were considered eligible in the further screening.

2.6) DATA COLLECTION PROCESS AND DATA ITEMS:

- All studies that met the inclusion criteria then underwent quality assessment and data recording.
- A standardized specifically designed data extraction form was used to record data and a data chart was prepared from each included study, encompassing number of patients, demographics, definition and diagnosis of TMJ derangement, clinical methods (assessment and treatment), follow-up duration, clinical and radiographic outcomes and patient-reported outcomes.
- Two review authors independently extracted data.
- When disagreement between the two reviewers was detected, consensus was achieved by discussion with the third reviewer/ statistical advisor.

2.7) RISK OF BIAS IN INDIVIDUAL STUDIES

The Cochrane Collaboration risk assessment tool was used for assessing the quality of included RCTs (Figure 1) . Studies were assessed by two reviewers independently.

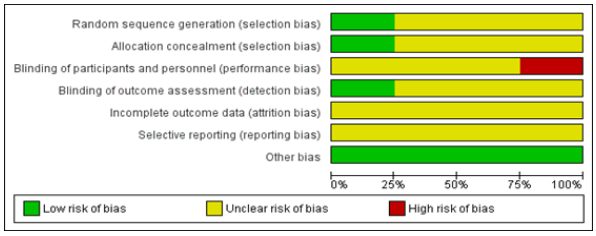


Figure 1: The Risk of Bias Of The Included Studies Were Categorized As Follows:

RESULTS

3.1) STUDY SELECTION:

The search strategy provided a total of 882 studies. After screening the title and abstracts, 9 studies were found to be duplicates of which 4 studies were excluded. The remaining 5 studies were potentially eligible and were screened entirely by the evaluators. At the end of the analyses, 4 articles published between 2016 to 2020 met the inclusion criteria and were included in the present systematic review. The flowchart of article screening and selection process is displayed in Figure 2.

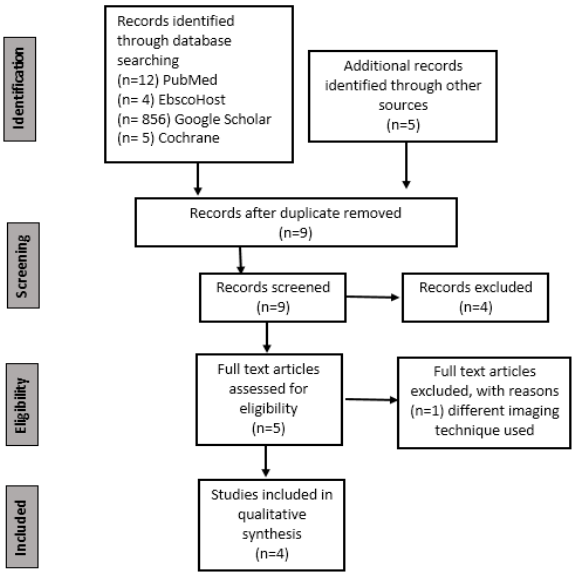


Figure 2: Prisma Flow Diagram

Table 1: Table of Excluded Studies

AUTHORS	YEAR	STUDY DESIGN	REASON FOR EXCLUSION
Abbasgholizadeh et al [7]	2019	RCT	Inclusion Criteria not met
Cha et al [8]	2018	Cadaveric study	Not a RCT
Champs et al [9]	2018	Technical note	Not a clinical study, sample size < 10
Chakraborty et al [10]	2016	Case report	Sample size < 10
Resnick et al [11]	2016	Retrospective study	Not on arthrocentesis

3.2) STUDY CHARACTERISTICS:

Details of the included studies are presented in Table 2. All studies were published in the last 5 years. Three trials[2,4,6] reported failed conservative therapy before arthrocentesis. The sample size of the included studies varied from 10 to 40 patients per group. Two studies[2,6] utilized the double-puncture technique of arthrocentesis, while the remaining two trials[2,5] used the single-puncture type 2 technique with different inflow and outflow ports. In the US-guided group, a probe was placed perpendicular to the zygomatic arch and parallel to the mandibular ramus in all studies for optimal visualization of the joint space. Arthrocentesis was carried out by a single operator for all patients in three trials[2,4,5]. Three trials reported data on the post-operative protocol, which consisted of mouth opening exercises and splint therapy in all studies[2,4,6]. The maximum follow-up ranged from 1 month to 1 year in the included trials.

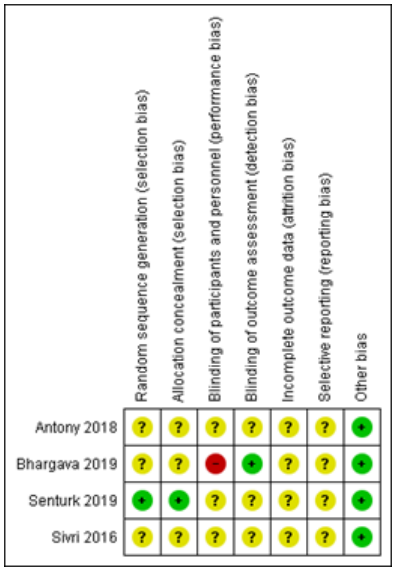
Table 2: Table of Study Characteristics

AUTHOR	YEAR	COUNTRY	STUDY DESIGN	AGE	SAMPLE SIZE	INTERVENTION & COMPARISION	PRIMARY OUTCOME	MEASUREMENT OF PRIMARY OUTCOME	FOLLOW UP
Sivri MB et al [6]	2016	Turkey	RCT	33.8	20pts	group1- conventional, group2- USG guided	number of relocations of needles, pain, duration of operation, MMO	Relocation of needle-surgeon, MMO-interincisal distance with graduated caliper	baseline, immediately after opt, 1week, 1and 3 months
Şenturk MF et al[2]	2017	Turkey	RCT	32.5	24 pts	group 1 - spa type 2 with US guided, group 2 - spa type 2 without US	Pain, preoperative jaw movements, including the MMO (mm), lateral excursion (mm), and protrusion (mm)..	Pain- VAS, MMO-interincisal distance with graduated caliper	one day, one week, and 1 year visits.
Antony PG et al [4]	2018	India	RCT	35.5	80 pts	control group-(conventional) experimental group (ultrasound guided)	MMO and pain	MMO- interincisal distance with graduated caliper, Pain- VAS	day 3, 1 week , 1 month
Bhargava D et al [5]	2019	India	RCT	NA	20pts	group A -single-puncture arthrocentesis group B- USG-guided single-puncture arthrocentesis	the number of attempts; the duration of the operation; pain	Relocation of needle-surgeon, Pain- VAS	VAS follow up-day 3,7,15 and 1 month

3.3) RISK OF BIAS WITHIN AND ACROSS STUDIES:

The methodological quality of the individual studies were evaluated using the Cochrane Risk of Bias 2.0 tool (Figure 3). Overall, all the studies reported as a high risk of bias.

Figure 3: Risk of Bias Interpretation



3.4) RESULTS OF INDIVIDUAL STUDIES:

The general information of selected studies is summarized in Table 2.

Three studies[2,4,6] recorded changes in MMO as an outcome measure. All three studies reported significant improvement in MMO in both groups of arthrocentesis with and without USG guidance. For USG-guided arthrocentesis group, MMO improvement after treatment ranged from 5.6 to 16 mm. MMO improvement after conventional arthrocentesis ranged from 4.1mmto 10.3mm.43 Only one study[4] reported greater MMO improvement with USG-guided arthrocentesis than conventional arthrocentesis, while the other two studies[2,6] found no differences between the two groups.

Three studies mentioned the attempts to position the needle during arthrocentesis for TMD.[2,5,6] No significant differences in the attempts to position the needle with or without USG guidance were observed in the study by Sirvi et al [6] and Şenturk et al [2]. The single-puncture arthrocentesis used in Bhargava et al. with USG guidance significantly reduced the attempts to position the needle ($p = 0.0007$).

All four studies reported reduction in pain as a major outcome of USG-guided or conventional arthrocentesis. Visual analogue scale (VAS) was used in all four studies. Studies reported significant post-operative pain reduction in both interventions. No significant differences in pain reduction were found between the USG-guided arthrocentesis and conventional arthrocentesis in the long term (post-operative 1 month to 1 year).

Only in the study by Senturk et al[2] later excursion and protrusive jaw movements were evaluated and showed no statistically significant differences ($p > 0.05$) between US guidance and without US guidance arthrocentesis groups.

DISCUSSION

4.1) SUMMARY OF EVIDENCE

US imaging of the TMJ has gained popularity in the past few decades. While MRI remains the gold standard for diagnosis of disc derangements, studies have demonstrated the utility of US for diagnosis of TMDs.[15] US can not only be used to detect inflammatory changes in the TMJ, but it also has good sensitivity and specificity for diagnosing disc displacements.[12,13,14] It is postulated that image-guidance can reduce complications, such as joint injury, damage to neurovascular structures, or needle penetration into the middle cranial fossa.[15,16,17] Although studies suggest, routine use of MRI or CBCT is not feasible for arthrocentesis, owing to the cost and requirement of a hospital setup for these methods. On the other hand, US is an inexpensive option without the hazards of ionizing radiation for image guided access to the TMJ. It has been hypothesized that US-guided TMJ arthrocentesis, by minimizing joint trauma and improving the accuracy of arthrocentesis, would improve the efficacy of the procedure.[6]

However, the results of this systematic review indicate otherwise. Pooled analysis of data after 1 week and 1 month of follow-up did not demonstrate any statistically significant difference in pain or MMO between US-guided arthrocentesis and conventional arthrocentesis. Only Antony et al[7] reported a significant difference in pain scores on the third post-operative day, attributing it to the reduced needle trauma in the US-guided group. However, on further follow-up, no such difference was noted. Further, it is important to note that the studies in the current review differed in the type of arthrocentesis technique, amount of fluid used for the joint lavage and postoperative protocol. These factors could have potentially influenced the outcomes of the included studies.

Systematic reviews have failed to demonstrate any conclusive evidence on the role of post-operative splint therapy[18] and intra-articular analgesics[19] in influencing postoperative outcomes after TMJ arthrocentesis.

Senturk et al[2] classified TMJ arthrocentesis techniques as double-puncture technique and single-puncture technique.

However, the number of needle manipulations to achieve outflow from the joint may vary with the single puncture and double-puncture techniques. Since the inflow and outflow ports are part of a single cannula system in the single puncture type 2 technique, fluid outflow is easier to achieve.[20]

On reviewing data from four studies, the authors found conflicting evidence concerning accurate needle placement in the TMJ with or without the use of US. Using the single-puncture technique, Senturk et al[2] reported successful needle penetration in the joint on the first attempt in all patients of both groups, but Bhargava et al[5], using the same technique, reported significantly reduced needle manipulations to achieve outflow with the use of US. With the double-puncture method, Antony et al[4] reported better success with the use of US, but Sivri et al[6] reported no difference in needle relocations in either study group.

LIMITATIONS

Certain limitations of the present systematic review are:

1. The quality of the all four included studies bore high risks of bias. The studies were all randomized clinical trial, but none of them followed the required CONSORT statement.
2. The sample size of three studies was fewer than 15 patients per group.
3. The included studies were heterogeneous for the inclusion criteria, type of arthrocentesis technique, amount of fluid used for the joint lavage, post-procedural intra-articular drugs, and postoperative protocol.
4. The intra-operative outcomes of arthrocentesis may depend upon the comfort and experience of the operator with a specific arthrocentesis technique. It is, however, difficult to take into account the influence of such confounding factors on the study outcomes when pooling results from different studies.

CONCLUSION

The systematic review did not find any evidence that USG-guided arthrocentesis is superior to conventional arthrocentesis. Higher-quality randomized clinical trials following the CONSORT statement are required to draw a more definitive conclusion as to whether USG-guided arthrocentesis is more effective in treating patients with TMD.

DECLARATIONS

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All authors listed have significantly contributed to the development and the writing of this article.

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Competing interest statement:

None

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