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Arthrocentesis techniques used in the treatment of temporomandibular disorders: Literature review

Riina Gudova[1, 2], Ülle Voog-Oras[1, 3], Oksana Ivask[1, 2]

SUMMARY

Objective. The article presents a systematic overview of single- and double-puncture techniques of arthrocentesis methods published in the Scopus database during 2016–2020, highlighting the advantages and shortcomings of different methods.

Materials and methods. A search was conducted in the Scopus database using the terms "TMJ OR temporomandibular OR mandibular OR jaw AND arthrocentesis". Arthrocentesis techniques were described and categorized mostly as single- or double-needle ones.

Results. The literature reviewed in the article represents studies of arthrocentesis treatment in 2675 patients involving 2740 joints.

Arthrocentesis techniques can mainly be divided into single- and double-needle techniques. Single-needle techniques are subcategorized into type 1 and type 2, of which the first is a single-needle cannula technique where inflow and outflow pass through the same lumen, while the second uses a Y-shaped device, which has two ports and two lumens. Double needle techniques use two needles – one for the inflow and the other for the outflow.

The literature found in the Scopus database during the period investigated presents 28% of single-puncture (type 1 – 10%, type 2 – 15%, single puncture with distention of the upper joint compartment – 3%), 69% of double-puncture, 1% of ancillary second-puncture methods and 1% employing a CBCT-based tragus-supported guide with 3 needles.

Conclusion. All of the arthrocentesis techniques described in the literature are effective as treatment modalities, none appears to be superior to others. The selection of the method to be used depends on the surgeon´s choice and experience.

Keywords: arthrocentesis, minimally invasive surgery, temporomandibular joint, temporomandibular disorders.

INTRODUCTION

Temporomandibular disorders (TMD) are musculoskeletal pain disorders of the masticatory system, i.e., of the temporomandibular joints (TMJs) and the masticatory muscles (1). They cause joint pain and limit mouth opening, thus having an adverse impact on daily living activities and the quality of life (2).

TMD treatment options usually start with conservative methods whose main aim is to relieve pain and restore normal mouth opening. If conservative treatment is not effective, minimally invasive surgical treatment options such as arthrocentesis are considered in order to maintain jaw movement and improve the quality of life. In contrast to arthroscopic procedures, TMJ arthrocentesis is performed without intra-articular visualization and consists in washing the joint space in order to reduce inflammatory mediators and release adhesions (3).

According to the literature studied for this article, the first time such a procedure was performed in the upper joint space of the TMJ was in 1987 by Murakami and co-authors. They used a pumping technique which later has been referred to as 'hydraulic distention' (4, 5).

The conventional method for arthrocentesis was first described in 1991 by Nitzan *et al.* who used a two-needle technique (6). The reference points for entering the TMJ were derived from the entry points for arthroscopy as described by McCain (7).

In 1998, Laskin performed the procedure using the same posterior entry point that was used by Nitzan *et al.* but placing the anterior needle in close proximity

[1]*Institute of Dentistry, Faculty of Medicine, University of Tartu, Tartu, Estonia*
[2]*Department of Facial and Jaw Surgery, Stomatology Clinic, Tartu University Hospital, Tartu, Estonia*
[3]*Denture Centre, Stomatology Clinic, Tartu University Hospital, Tartu, Estonia*

Address correspondence to Riina Gudova, Institute of Dentistry, Faculty of Medicine, University of Tartu, Puusepa 1a, 50406 Tartu, Estonia.
E-mail address: riina.gudova@kliinikum.ee

(3–4 mm) parallel to the posterior one. In his view, arthrocentesis did not require access to the anterior recess of the joint and such a placement had the advantage of being easier to perform (8).

In 2009, Alkan and Kilic introduced automated-irrigation arthrocentesis of the TMJ – essentially, this represents double-puncture arthrocentesis with one of the needles connected to a surgical implant motor. The modification resulted in higher hydraulic pressure in the joint and a shorter duration of the procedure (9).

Arthrocentesis can also be performed with only one needle. Single-needle arthrocentesis with a three-way stopcock was described by Alstergren *et al.* in 1995 (10).

To gain stable access to the TMJ and to make the procedure more tolerable for the patient, single-needle techniques were developed further (11). In 2008, Guarda-Nardini reported using a single needle with a single port and, in 2009, Rehman and Hall used the Shepard cannula, which has two ports (11, 12). In 2015, Şentürk and Cambazoğlu classified arthrocentesis methods into single- and double-puncture ones with single-puncture methods subcategorized as type 1 and type 2 (13). Single-needle techniques use one puncture point and a single needle, while double-needle techniques use two puncture points and two needles. The subcategorization of single-needle techniques reflects differences in the number of needle ports and lumens. The introduction of arthrocentesis was almost immediately followed by reports of various means being employed to visualize the TMJ during the procedure. In 1991, Nabeith and Speculand were the first to use ultrasonograhpy (US; 14). In 2006, Honda and Bjørnland described a technique for puncturing the upper temporomandibular joint space with the aid of cone beam computed tomography (CBCT; 15).

In 2020, a network meta-analysis was published of randomized clinical trials of treatments of arthrogenous TMDs. The analysis concluded that pain relief and mouth opening improvements were achieved faster by intra-articular injections, arthrocentesis and arthroscopy than by conservative treatment methods and recommended the use of minimally invasive procedures (including arthrocentesis) as a first-line surgical treatment in TMD cases prior to or simultaneously with conservative methods (16).

The aim of this study is to provide a systematic overview of single- and double-puncture techniques of arthrocentesis as described in the Scopus database in 2016–2020.

MATERIALS AND METHODS

A search was conducted in the Scopus database for articles published in the English language during the years 2016–2020 using the terms "TMJ OR temporomandibular OR mandibular OR jaw AND arthrocentesis". The initial number of articles returned by the search was 135. The titles of the articles were then screened to identify those describing the use of arthrocentesis as the main or a supplementary treatment method. Studies using cadavers or animals were excluded. A further body of articles that was excluded consisted of 23 meta-analyses, systematic reviews or reviews. Additionally, 30 articles were left out due to various reasons: 27 did not contain information about the use of arthrocentesis methods or were not freely available, 1 was a book chapter and 2 described technical tools related to arthrocentesis.

The final number of articles that qualified for this study was 59.

RESULTS

The articles analyzed in the study describe the administration of arthrocentesis treatment to a total of 2675 patients and 2740 joints. Not all of the articles reported a breakdown of the patient sample by gender. In all studies described in the articles, arthrocentesis was performed according to surgical requirements under local anesthesia. For the most part, the techniques employed in the studies may be categorized as single- or double-puncture methods. Some of the techniques employed extra visualization by radiologic means such as US, CBCT or computed tomography (CT). The material included 28% of single-puncture (type 1 – 10%, type 2 – 15%, single puncture with distention of the upper joint compartment – 3%), 69% of double-puncture, 1% of ancillary second-puncture methods and 1% employing a CBCT-based tragus-supported guide with 3 needles. Radiological imaging methods were used in 8% of the studies. A schematic diagram shows all arthrocentesis techniques described in the material (Figure).

TMJ reference points

The most often used references for entering the temporomandibular joint were the Holmlund-Hellsing line (HH-line) and certain points related to it. The HH-line or tragus-to-lateral-canthus line is an imaginary line from the lateral canthus of the eye to the mid-tragus of the ear. The usual entry points are those at the 10-2 and 20-10 locations. The 10-2 point is 10 mm from the tragus of the ear and 2 mm below the HH-line and correlates with the posterior recess in the glenoid fossa. The 20-10 point is 20 mm from the tragus of the ear and 10 mm below the HH-line, corresponding to the prominence of the articular eminence (17).

The material also includes certain variations (Table).

Single-puncture techniques

Type 1 subcategory of single-puncture techniques consists in inserting a single-needle can-

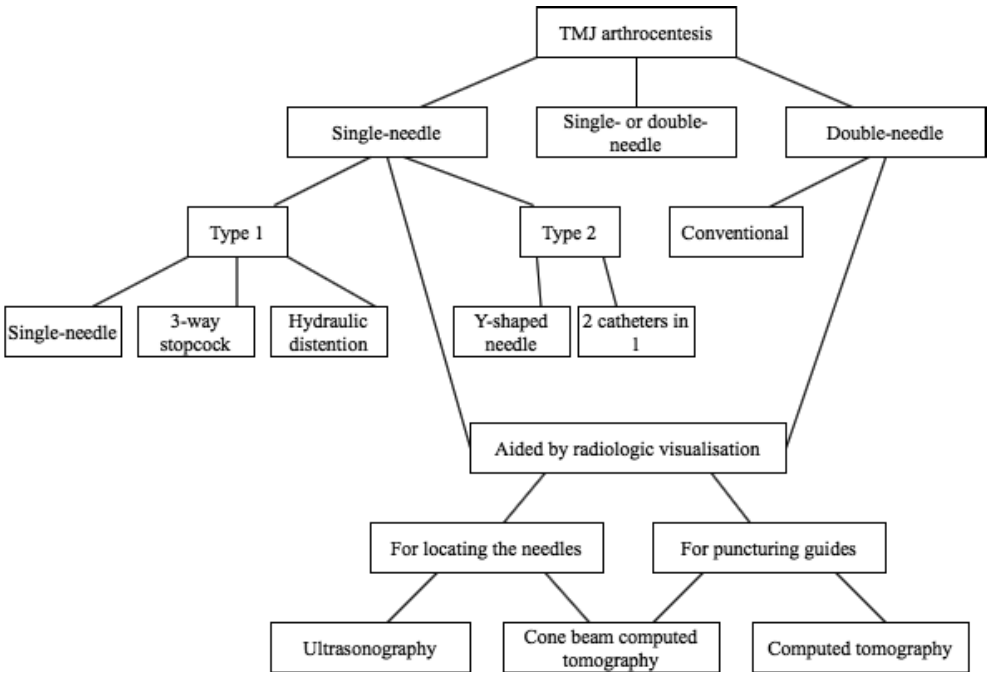

Fig. TMJ arthrocentesis techniques published in the Scopus database in 2016–2020

nula that uses the same lumen for both inflow and outflow, while type 2 employs a Y-shaped device which has two ports and two lumens (11, 24, 25). A comparison of single-puncture type 1, single-puncture type 2 and double-puncture techniques conducted by Şentürk *et al.* found single-puncture type 2 arthrocentesis to be easier to perform and less time-consuming (21). In contrast, a study by Bayramoğlu and Tozoğlu reported equal effectiveness and tolerability in respect of single-puncture type 1 and double-puncture arthrocentesis performed as part of the study (26).

A single-puncture type 1 technique using a three-way stopcock performed by Ivask *et al.* also showed good results. A 19-gauge needle was inserted into the posterior space of the upper compartment of the TMJ. A three-way stopcock was connected to the needle and two syringes to the stopcock. Arthrocentesis was performed using a push-and-pull method. The equivalence of inflow and outflow was ensured by using syringes of equal volume (27).

Table. Variations of entry points to TMJ space

Author	First entry point (mm)		Second entry point (mm)	
	In front of the tragus	Below the HH-line*	In front of the tragus	Below the HH-line
Holmlund and Hellsing (1985; 17)	10	2	20	10
Hanci *et al.* (2016; 18)	10	2	20	6
De Barros Melo *et al.* (2017; 19)	10	0.5	20	1
Laskin (2018; 20)	10	2	13-14	2
Sentürk *et al.* (2018; 21), Santagata *et al.* (2020; 22)	10	2	7	2
Bas *et al.* (2019; 23)	10	2	20	8

* – Holmlund-Hellsing line

A single-needle hydraulic distention technique of the upper compartment of the TMJ was performed by Grossmann *et al.* in 2017. They injected 4 ml of fluid into the TMJ, removed the syringe and the needle and instructed the patients to perform opening and lateral movements with the TMJ to release the adhesions that had formed in the joint (5).

Single-needle type 2 arthrocentesis represents a modification of the basic single-needle technique. Different options using the type 2 principle have been employed, for example those using the Shepard cannula or a modified double-lumen single-barrel needle (12, 28). For instance, Mun *et al.* made their device from two 18-gauge needles which were bent to form the shape of the letter "Y", with the bevels facing each other (29).

Variations have also been reported for type 2 single-needle arthrocentesis. In 2016, Skármeta *et al.* described a technique that used a single peripheral intravenous cannula through which a needle matching the inner diameter of the cannula tube was inserted to introduce the solution. When the needle was retracted slightly (3–4 mm, to lie level with the tip of the cannula), the cannula tube allowed the solution to flow out (30). In 2017, Nagori *et al.* described a similar technique, in which they used parts of two peripheral intravenous catheters of different gauges, with the larger catheter tube providing an outflow port and the needle of the smaller cannula an inflow port (31).

Double-puncture techniques

Double-puncture techniques dominated in the material. They consisted in inserting a needle into the superior joint space at the glenoid fossa and injecting a solution for distending the joint space. A second needle was then inserted into the area of articular eminence. One of the needles functioned as the inflow and the other as the outflow (6, 32).

Double-needle arthrocentesis technique has proven effective either with or without the use of additional medications. Cömert Kiliç and Güngörmüş used double-needle arthrocentesis to compare administrations of platelet-rich plasma and hyaluronic acid and Bergstrand *et al.* used the same technique to compare the effects of basic arthrocentesis (without administration of medications to the TMJ) and of arthrocentesis with administration of hyaluronic acid. Neither of the studies reported any difference in terms of the effects of the treatment modalities compared (33, 34).

Ancillary second-puncture techniques

Park *et al.* described a technique for distending the upper joint space. Preparation for the procedure was performed as usual – two insertion points were marked, one on the articular fossa and the other on the articular eminence, respectively 1 and 2 cm in front of the tragus along the canthal-tragal line. The needle of a syringe was inserted into the upper joint space and about 2 ml of normal saline solution injected to distend the joint. If resistance in the joint was high, a second needle was inserted. 30–50 ml of normal saline was used for lavage. To increase joint space, the patient's mandible was manipulated along the vertical axis (35).

Arthrocentesis with radiologic visualization

Radiologic visualization can be used with single as well as double-needle techniques.

Ultrasonography can be of assistance when locating the upper joint space of the TMJ and inserting a needle for arthrocentesis. Two different techniques with US guidance have been described: double puncture and single puncture with a modified double-lumen single-barrel needle (36, 28, 37).

Cone beam computed tomography has also been used for making TMJ puncturing guides. Gocmen *et al.* used CBCT to design a tragus-supported punction guide. The position of the needles was verified by US (38). Mahmoud *et al.* used CT scanning to design a puncture guide for the inflow and outflow needles. Access to temporomandibular superior joint space was verified clinically and arthroscopically (39).

DISCUSSION

All arthrocentesis methods described in the 2016–2020 material selected for study from the Scopus database are effective as treatment modalities for reducing pain, improving jaw function and raising the patient's quality of life. Our review of the articles describing the methods revealed only minimal differences between single- and double-puncture techniques.

A meta-analysis published in 2020 by Monteiro *et al.* showed that single- and double-puncture techniques had no difference in respect of maximal mouth opening achieved. Double-needle arthrocentesis was assessed as slightly better in terms of pain reduction (40). The same conclusion was reached in a systematic review of different types of arthrocentesis techniques by Nagori *et al.* (41). The reason may lie in the fact that, as a surgical procedure, arthrocentesis is less invasive than other treatment methods and, in addition to being effective in terms of reduction of the pain caused by the patient's condition, itself involves relatively little pain – regardless of which modification of the technique is used.

Some studies claimed that single-needle arthrocentesis was technically easier to perform than the double-needle technique (42, 43). Introducing a single needle could make the joint space more easily accessible, taking into account the fact that inflammatory disease may lead to severe narrowing of the TMJ compartment and may render it very difficult, even for an experienced surgeon, to insert two needles.

It has been proposed in the material that techniques involving a single puncture are more tolerable for the patient (11) – the insertion of only one needle into an already pain-sensitive joint may be less stressful and easier to bear psychologically.

On the other hand, the use of a single-needle single-lumen technique results in higher pressure and more irritation in the joint space (44). In cases of chronic inflammatory disease, the absence of a separate outflow conduit may further increase the pressure in the TMJ and cause more pain and discomfort for the patient.

In contrast, the studies by Manfredini *et al.* and Guarda-Nardini *et al.* found no difference in the tolerability of single- as opposed to double-needle arthrocentesis (45, 44).

The presence of an outflow can have an impact on the time required for the procedure. Single-needle arthrocentesis could take more time or lead to a reduction in the amount of lavage solution used. Attempts to optimize procedure duration are likely to influence the amount of the solution used to irrigate the joint. Single-puncture arthrocentesis was found by Talaat *et al.* to reduce the duration of the procedure (42), while Bayramoğlu *et al.* found in their study that the opposite was the case (26). A study by Kaneyama *et al.* found that in order to remove inflammatory agents such as bradykinin, 300–400 ml of fluid must be irrigated through the TMJ (46). We support the opinion that 200 ml of irrigation fluid is sufficient to achieve this purpose, but find that such an amount can be difficult to achieve with type 1 single-puncture technique because it does not allow for a simultaneous outflow.

Pasqual *et al.* compared the conventional double-puncture technique with single-needle upper joint space distention (47) and found that the double-

puncture technique allows for more effective irrigant effusion. Due to the pressure created in the upper joint space, double-puncture techniques could be more effective for releasing the adhesions of chronic inflammation. On the other hand, in cases of severe fibrosis in the joint space, inserting the second needle may prove complicated. Several attempts to introduce the second needle – at a location close to the path of the facial nerve (11) – may give rise to complications. In cases where fibrous adhesions are overwhelming the joint compartment, other surgical methods should be considered as treatment modalities.

To simplify the procedure – especially for less experienced surgeons – in addition to single-needle puncture techniques, Laskin's (8) modification of the double-needle technique should be considered. In Laskin's view, TMJ arthrocentesis can be performed without accessing the anterior recess of the joint – which might prove difficult to achieve because of the narrow conditions. A study comparing double-needle arthrocentesis with conventional needle placement as suggested by Nitzan *et al.* (6) and with parallel needle placement as suggested by Laskin (8) found the latter to be less time-consuming and easier to perform (48).

In conclusion, none of the arthrocentesis techniques described in the material stands out as clearly superior to others. As studies comparing single- and double-needle arthrocentesis techniques are heterogeneous in terms of factors such as the sample of patients, the arthrocentesis protocol followed, the medications used during the procedure, etc., to date only a few overview studies have been published. It is still not clear which arthrocentesis technique should be preferred. Single-puncture techniques were developed to make the procedure simpler and smoother. Nevertheless, they also have their shortcomings. Although none of the techniques described in the material can be recommended as clearly superior over others in terms of reduction of pain and restoration of maximum mouth opening, arthrocentesis as a method has proved effective. The particular technique to be used is for the surgeon to decide, having regard to the greater wellbeing of the patient.

CONCLUSION

Systematic overview of the single- and double-puncture techniques of arthrocentesis described in the 2016–2020 material selected for this study from the Scopus database shows no evidential superiority of one over the other. The selection of the method used depends on the surgeon´s choice and experience.

STATEMENT OF CONFLICTS OF INTEREST

The authors state no conflict of interest.

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