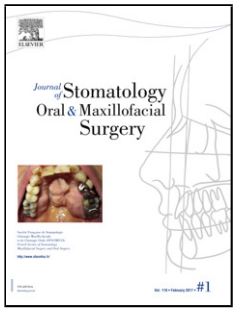

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US-guided temporomandibular joint injection: validation of an in-plane longitudinal approach

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Abstract

Ultrasonography of the temporomandibular joint is a non-invasive imaging technic, easy to perform in daily practice. It can be used for diagnosis and to guide intra-articular injections. The objective was to validate a longitudinal in-plane US injection approach of the joint and assess its accuracy. We performed a study in 13 non-embalmed cadavers. The injection was done under real-time US guidance using a needle inserted in-plane with an angulation of 30°and positioned under the capsule until the injection was feasible without resistance. The intra-articular injection was successful in all cases and confirmed by a liquid backflow in 96 % of cases. The median duration between skin puncture and the intra-articular injection was 23 seconds. Our technique allows a direct visualization of the needle throughout its course to the joint with a high accuracy. Other studies will be needed to confirm its feasibility and usefulness in patients with TMJ disorders.

Keywords: Ultrasound guidance, temporomandibular joint, in-plane injection, accuracy

Introduction

The temporomandibular joint (TMJ) connects the temporal bone and the mandible. It is a complex joint with 2 compartments separated by a fibrocartilaginous disk that provides translational as rotational movements. Pain or dysfunction of this joint can originate from osteoarthritis, inflammatory arthritis, disk displacement or myofascial pain dysfunction. Intra-articular injections are a therapeutic option in those conditions. Steroids, hyaluronic acid or platelet rich plasma (PRP) can be injected directly in the joint cavity (1,2). Irrigation of the joint cavity can be used in patients with symptomatic internal derangement (3). These injections can be performed with a landmark-based approach but imaging guidance with CT scan, MRI or ultrasound increases their accuracy and could minimize the risk of potential complications (4).

MRI and CT scan remain the gold standard for the diagnosis and in the therapeutic management of temporomandibular disorders. However, US has several advantages such as its high availability, low cost and the lack of irradiation for the patient and the physician. Ultrasonography of the TMJ has shown its interest in the diagnosis of disk position abnormalities, joint effusion, and bone pathologies (2). However, it remains less sensitive than MRI because limited by the acoustic shadowing induced by the zygomatic arch and the mandibular condyle (5). Several studies have evaluated the interest of US to guide TMJ arthrocentesis or lavage (6–12). However, some of these studies have been performed several years ago with low frequency probes that did not allow a proper characterization of the structure of the joint. Moreover, the route of injection varies between these studies: some used an out of plane approach while others in-plane; some authors performed this injection on a longitudinal scan and other in a transverse one. Finally, the accuracy of these different approaches was not systematically assessed.

US anatomical landmarks of the TMJ are best depicted on a longitudinal scan of the joint that allow the visualization of all the components of the joint: the mandibular condyle, glenoid fossa, the capsule and the disk (13). An in-plane approach allows the visualization of the needle during the entire procedure (14). Therefore, we thought that a longitudinal in-plane approach would be the best route to inject TMJ joint. The goal of the present study was to validate this route and assess its accuracy in cadaveric specimens.

Material and methods

We first performed a literature review on articles published on US-guided TMJ injections. We next performed a study in non-embalmed cadaver at the Nantes anatomy facilities. Local Institutional Review Board and Ethics Committee approval was obtained for use of human anatomical specimens. The procedure was performed with the mouth closed. For ultrasound control, we used a Toshiba applio 500 ultrasound scanner, Toshiba system, Puteaux, France. TMJ were studied and injected in a longitudinal plane. The US probe was first positioned in the pre-auricular region, approximately 1 cm in front of the tragus, parallel to the mandibular ramus and perpendicular to the zygomatic arch. The mandibular ramus was depicted on US as a flat bone ascending to the condyle. On this scan, the glenoid fossa is located between the 2 hyperechoic lines representing the mandibular condyle and zygomatic arch of the temporal bone (**Figure 1**). In this area, the capsule, the articular disk, the inferior and superior articular cavity cannot be clearly differentiated by US and appears as a triangular isoechoic or hyperechoic area. The target for the injection was this triangular area. On experienced rheumatologist (BLG) performed all the injections using a 21G needle. The needle was inserted in-plane with an angulation of 30°and advanced under the capsule until the injection was feasible without resistance (**Figure 2**). If the injection was not possible under the capsule, the needle was gently advanced toward the articular eminence until a loss of resistance was obtained. The success of the injection (intra-articular) was defined by the presence of a liquid back-flow from the needle and/or a distension of the TMJ joint visualized by US during the injection. We recorded the time between the puncture and the intra-articular injection as well as the percentage of success of the injection. We

categorized the adjustments as “minor” if the needle was moved slightly to optimize its position, “re-orientation” if the needle tip was partially withdrawn and re-orientated and “withdrawal” if a new puncture was performed.

Results

Characteristics of the different studies on US-guided injection of the TMJ are summarized in **Table 1**. There were one case report, one technical note and 5 series of patients. Two studies reported injections in children with juvenile idiopathic arthritis (JIA) and 3 in TMJ dysfunction. Two studies used an in-plane longitudinal approach but did not assess the accuracy of the injections.

We injected 25 TMJ in 13 cadavers. One TMJ could not be injected for technical reasons (the head could not be moved properly to have access to the joint). The injection was successful in all cases (100 % accuracy). In 96 % of cases, the presence of a liquid backflow confirmed the intra-articular position of the injection. In one case no backflow could be obtain but the intra-articular position was confirmed by the distension of the TMJ visualized on US. The median duration of injection (from the puncture to the intra-articular injection) was 23 seconds (9-55 seconds). We performed minor adjustment or re-orientation in 9 cases; in one case, two minor adjustments or re-orientation were necessary. None of this situations needed new needle puncture.

Discussion

In this study we chose a longitudinal, in-plane approach to inject TMJ joint under US guidance. US guidance can be performed either in an in plane or out of plane technic with some advantages and drawback. With an in-plane approach, the needle and the surroundings can be continuously visualized during the procedure. This is useful in a region where several nerves and vessels (superficial temporal artery and maxillary artery) course around the joint (15). However, the needle will need a longer path to reach its target. Longitudinal scan of the joint allows a better visualization of the anatomical

structures (2). Moreover, in view of the anatomy of the glenoid fossa, the best direction to access to joint cavity is longitudinal, slightly superior with a caudal to cranial approach (5). Therefore, we considered the longitudinal in plane approach as the method of choice to perform the injection.

As summarized in our literature search (Table 1), different routes have already been described to perform this injection. However, the description of the protocol was sometimes unclear with some discrepancies between the description and the pictures given as illustration. Parra DA et al. 2010 described their experience of US guided injection of TMJ joint in JIA patients (6). They also performed a longitudinal scan of the TMJ joint but the injection was out of plane a slightly cephalad and posterior angle. Levorova J et al. 2015 used a longitudinal in-plane but did not evaluate the accuracy of the injection (9). Moreover, they report that the needle might be hard to visualise as the same time than the joint cavity. Indeed, the image given in the article did not clearly depict the site of injection and the needle tip. They used an in plane injection with a needle inserted at an angulation of 60° to expected the top of the condyle. We propose to inject in the joint space above the mandibular condyle with an angulation of the needle of 30°. Using this technic, the needle can be followed up to the joint cavity as shown in Figure 2.

One of the features of the temporomandibular joint is its articular disc. This disc is composed of dense fibrous connective tissue that divides the joint into two compartments which consists of an upper and a lower synovial cavity. We were unable to discriminate the two cavities with US despite the use of high frequency probes. This is in line with other authors that mentioned that the different components of the joint are best studied using other imaging technic such as MRI (5). Therefore, it is difficult to assess if the injections targeted the superior or inferior compartment of the TMJ. This is in contrast with some authors that argued being able to differentiate between the upper and lower joint cavity and inject them separately. In their study, Moon S-Y et al. 2015 described injections of the superior joint space (12). However, the US images shown in the article was performed with a low frequency probe, using a transverse view of the mandibular condyle and an out of plane approach. No arthrography has been

made to confirm the location of the injection. Levorova J et al. 2015 described in a technical note their approach to the inferior articular cavity of the TMJ joint (9). The backflow of fluid confirmed that the injection were intra-articular but cannot confirm if the injection was made in the upper or lower articular cavity.

In our study, accuracy was not assessed with CT or arthrography. However, the presence of a backflow of fluid associated with the distention of the joint cavity is observed only in case of intra-articular injection. None of the studies dealing with US-guided injection of the TMJ evaluated the accuracy of their injection with arthrography. For instance, Parra DA et al. 2010 found that their needle placement was “acceptable” (i.e. within the joint) in 115/127 joints (91%) (6). They estimated indirectly the success of the injection by visualization of the needle tip on CT images (4). Sivri MB et al. 2016 used the backflow of fluid as a confirmation of intra-articular injection (10).

Conclusion

Ultrasound is a non-invasive method, easy to perform in daily practice. Our technique allows a direct visualization of the needle throughout its course to the joint with a high accuracy. Other studies will be needed to confirm its feasibility and usefulness in patients with TMJ disorders.

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Figures legends

Figure 1: A. Longitudinal Ultrasound scan of the TMJ (red dotted line -> delimitation of the articular capsule of the TMJ). ; B. Descriptive drawing of the anatomy of the temporomandibular joint.

Figure 2: A. US-guided injection of the TMJ in a longitudinal in plane route (The needle is the hyperechoic line indicated by a yellow arrow. Note that the needle bevel is clearly seen facing down under the capsule). B. Illustrative photograph of temporomandibular joint injection under ultrasound guidance.

Figure 1

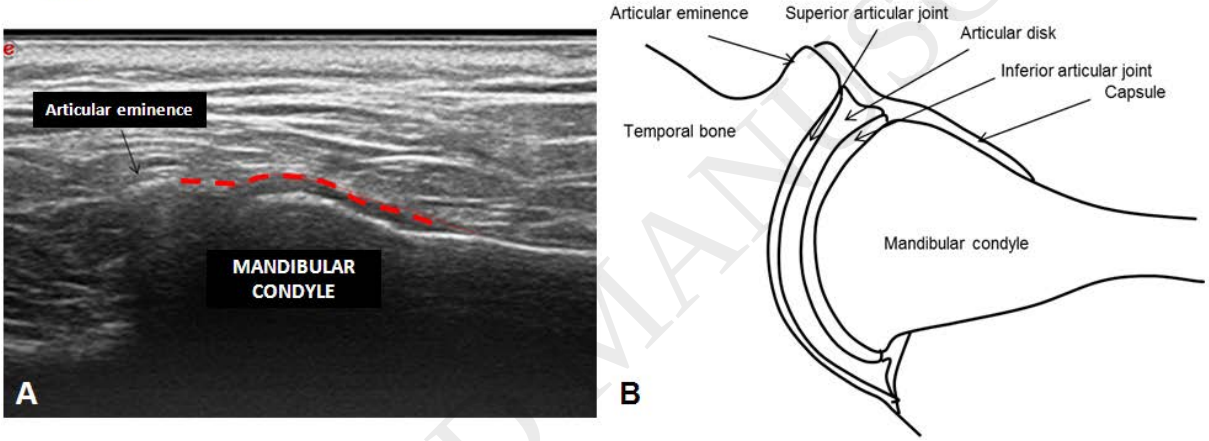

Figure 2

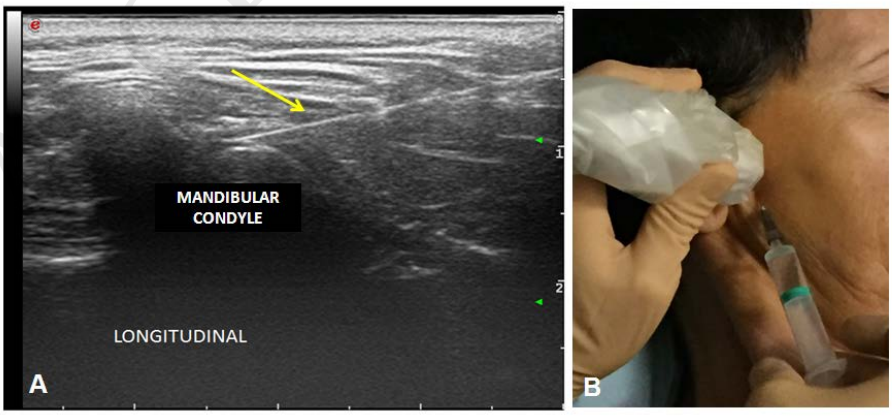

Table 1 : Characteristics of the different studies on US-guided injection of the TMJ.

Reference	Patients/indication	Type of procedure	Route	Accuracy criteria and results
Parra DA et al. 2010 (6)	83 children with JIA (180 injections)	Triamcinolone Hexacetodine & Acetodine injections	Longitudinal scan, out of plane	Intra-articular location of the needle assessed by CT in 91% of the cases
Habibi S et al. 2011 (7)	38 children with JIA	Triamcinolone Hexacetodine injections associated with an	Not clearly described	Not evaluated
Dayisoylu EH et al. 2013 (8)	9 patients with TMJ dysfonction	Articular lavage	Transverse scan, out of plane	4 out of 9 patients had intra-articular procedure
Moon S-Y et al. 2014 (12)	27 patients with TMJ dysfonction	PRP injection	Not clearly described	Not evaluated
Levorova J et al. 2015 (9)	_	_	Longitudinal scan, in plane	Not evaluated
Sivri MB et al. 2016 (10)	10 patients with dysfunction of the temporomandibular joint	Articular lavage	Not clearly described	Back-flow of lidocaine in all patients
Chakraborty A et al. 2016 (11)	1 patient with posthemimandibulectomy controlateral jaw pain	Lidocaine & triamcinolone injections	Longitudinal scan, in plane	Not evaluated

JIA : juvenile idiopathic arthritis ; PRP : Platelet-Rich Plasma ; _ Not available.