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ULTRASOUND GUIDED VERSUS CONVENTIONAL SINGLE NEEDLE ARTHROCENTESIS

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ABSTRACT

Objective: the present study was performed to Comparison between Ultrasound guided versus conventional single needle arthrocentesis. **Subjects and Methods:** Sixteen patients were selected for arthrocentesis. After arthrocentesis. Patients were divided randomly into two groups, each comprised 8 patients: Group 1: arthrocentesis was performed through the conventional single puncture method. Group 2: arthrocentesis was conducted with the needle insertion guided with US. each patient were evaluated clinically at the following interval one week, two weeks, one month, 3 months and 6 months postoperatively for: Pain, Maximum mouth opening, Right and left maximum excursive movements, TMJ clicking, and Tenderness of TMJ related muscles, and radiographically MRI were taken 6 months after arthrocentesis. **Results:** US group was 1.13±0.35attempts for needle manipulation while conventional group was 2.75±0.46 attempts for needle manipulation. US group was 12.88±0.99 min in operative procedural time while conventional group was mean 18.75±1.58 min in operative procedural time. US group was successful in 100.0 % while conventional group was 62.5 % with 12.5 % liquid backflow to the needle, 12.5 % distension of the TMJ, and 12.5 %liquid outflow form ear. There was no statistically significant difference between degree of pain in the two groups. **Conclusion:** Maximal mouth opening improved with conventional and US guided arthrocentesis. Successive increase in maximal mouth opening was observed during follow up periods. MRI findings indicated that there was no change in disc position even after improvement of mouth opening. US-guided technique significantly improved the accuracy of intra-articular injections, but not the outcomes of the injections.

KEY WORDS: Arthrocentesis; TMJ; Ultrasound; single needle; clicking

INTRODUCTION

The temporomandibular joint (TMJ) is a unique joint in the body; it is composed of stress-sensitive cartilage that is subject to extensive tissue remodeling. TMJ disorder is one of the most difficult clinical problems to diagnose and manage in the field of oral and maxillofacial surgery [(1)]. It affects the quality of life sharply, with a prevalence of 10 % to 70 % in the population, and is more epidemic in women between 20 and 40 years of age. Temporomandibular disorders (TMD) usually involve TMJ, masticatory muscles, and other relevant structures accompanied by craniofacial pain, limited mouth opening, sounds such as clicking or crepitus, irregular or deviating jaw function and often complicated by symptoms of chronic head and neck pain [(2)].

TMJ Internal Derangement (ID) is a common form of TMD, almost 80% of adult symptomatic patients with TMD have some form of ID [(3)].

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In the past, treatment of TMJ dysfunction that did not respond to conservative treatment was the surgical disc repair and repositioning to reestablish the normal maximum mouth opening (MMO)[4]. Data from related literature has suggested that arthrocentesis may be of some benefit to manage symptoms of TMDs. Such a technique was first introduced for the management of sudden onset of closed lock [5].

Arthrocentesis of the TMJ has emerged over the years as a useful technique to manage restricted mouth opening. Is considered the first-line treatment of various internal derangements of the TMJ and is also used for diagnostic purposes [6]. It may have many advantages; it is considered as the least invasive surgical intervention into the TMJ, can effectively reestablish a normal maximal mouth opening and can reduce pain and dysfunction. Besides, it is also relatively easy to perform and carries very low risk morbidity [7].

Arthrocentesis technique was first described by Nitzen et al [8]. The technique involves irrigating the upper joint space together with joint manipulation aiming at releasing adhesions, improving function and washing inflammatory mediators away from the joint [9]. The procedure also involves inserting two large cannulas into the upper joint space; one cannula allows irrigation with normal saline, and the other allows the mixture of synovial fluid and saline to flow out [10]. Proposals for single-needle arthrocentesis suggest improving the success rate, reducing the execution time, limiting the trauma of the intervention in order to reduce patient pain and disability during the postoperative phase, and reducing the risk of side effects [11].

Identification of the upper joint space is important for successful lysis and lavage, so reference points have been laid down. However, the use of the "blind" technique to reach the upper joint space requires experience, and carries a risk of damage to the collateral ligaments of the disc and the adjacent soft tissue [12].

For obtaining a diagnostic imaging of TMJ, clinicians used to require magnetic resonance imaging (MRI) and Ultrasound (US) imaging [13]. Moreover, ultrasonography can be used as an intra-operative guide to ideally insert the needle into the superior joint space of TMJ. US guided lysis and lavage of the TMJ may permit real-time dynamic imaging, good soft tissue contrast, easy to perform, cost effective and may identify sites of inflammation by detecting the presence of articular effusion [14].

SUBJECTS AND METHODS

Sixteen patients were selected from those attending the Outpatient Clinic of Oral and Maxillofacial Department, Faculty of Dental Medicine, Al-Azhar University and Sayed Galal University Hospital with symptomatic complaints of unilateral or bilateral TMJ disorders. All patients have documented findings of internal derangement of the TMJ and indicated for arthrocentesis. Two group comprised of 8 patients: Group 1: arthrocentesis was performed through the conventional single puncture method. Group 2: arthrocentesis was conducted with the needle insertion guided with US. Each patient were evaluated clinically at the following interval one week, two weeks, one month, 3 months and 6 months postoperatively for: Pain, Maximum mouth opening, Right and left maximum excursive movements, TMJ clicking, and Tenderness of TMJ related muscles, and radiographically MRI were taken 6 months after arthrocentesis.

Exclusion of patients included, those who have undergone arthrocentesis before, patients who have undergone any previous surgery at the TMJ region, patients who have had a tumor affecting TMJ, and patients who were subjected to radiation therapy to TMJ area.

Clinical parameters

All patients were evaluated clinically for: Pain; through visual analogue scale (VAS). Maximum mouth opening (MMO) with caliper in millimeters (Fig 1). Right and left maximum excursive movements with caliper in millimeters. TMJ clicking. Tenderness of TMJ related muscles.

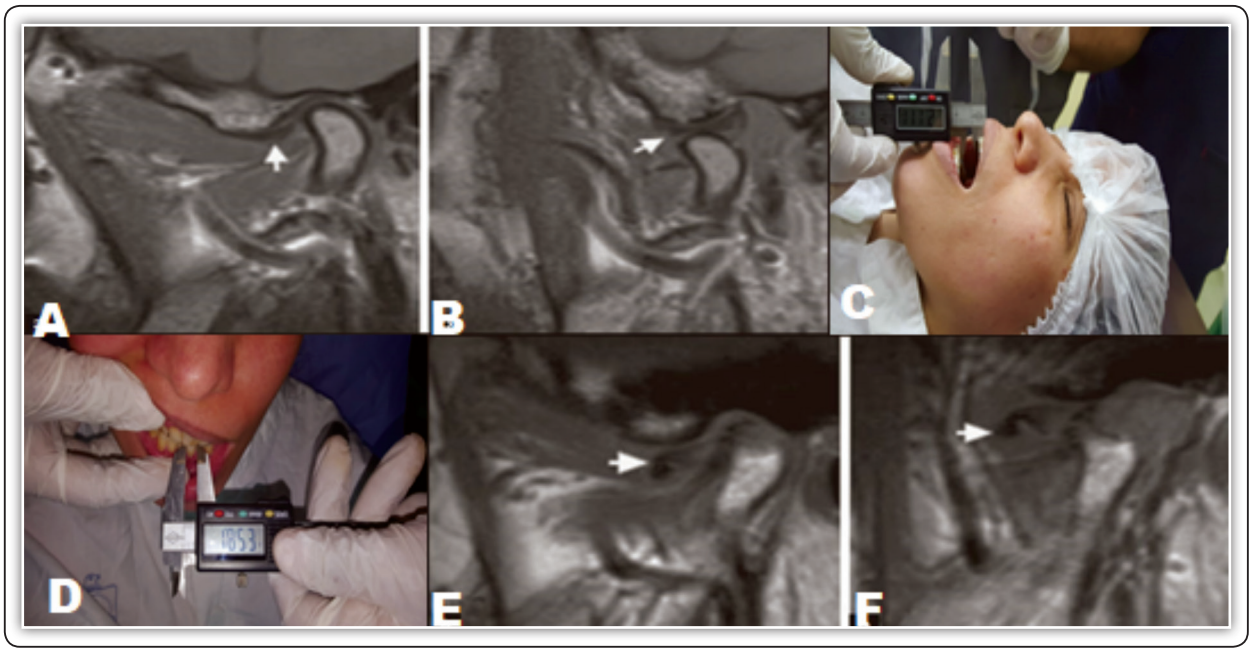

FIG (1) A; T1-Weighted sagittal magnetic resonance images of one case in closed, B; open-mouth positions showing anterior disc displacement with reduction, C; preoperative maximum mouth opening measurements, D; preoperative left and right lateral excursive movement's measurements, E; T1-Weighted sagittal magnetic resonance images of another case in closed, F; open-mouth positions showing anterior disc displacement without reduction

Radiographic parameters:

MRI were taken 6 months after arthrocentesis for documentation and for comparison with the preoperative ones, Fig (1).

(A) Preparation of the double lumen single barrel needle:

The needle was prepared using two 20-gauge needles from intravenous cannulas. Both needles were bent and soldered to give a Y-shaped design where the bevel ends were conforming the single vertical limb of the "Y" while the syringe adaptor ends conforming the bent limbs. The bend was given at 30-degree angle to each needle and soldered from the barrel convergence up to 3 mm short of biangular bevel. Keeping the solder 3 mm short of the bevel prevents thermal damage to the needle tip and the bevel. The bevels of the needles were oriented in such a way that the needle tips remain approximating and bevel facing the opposite direction. The double lumen single barrel needle was sterilized using class B autoclave.

(B) Arthrocentesis:

a) Conventional procedure (Group 1):

The mandibular condyle was palpated while the patient was instructed to open his mouth the maximum opening. The double lumen single barrel needle was inserted into the superior joint space through the marked entrance point. The position of the needle was assured by mandibular manipulation. The time between the puncture and the intra-articular injection as well as the percentage of success of the injection was recorded. Success of the injection was defined by free outlet of the solution without resistance. Aspiration was done to eliminate the possibility of vascular involvement. A total of 100 ml Ringer lactate solution was used to lavage the superior joint space. During this procedure the mandible was manipulated through opening and closing. Then, needle was withdrawn and area was covered with a dressing moistened with antiseptic solution.

b) US guided procedure (Group 2):

The imaging protocol includes transverse and longitudinal scans so the antero-superior joint compartment can be examined in coronal, axial and oblique views. A sterile US probe (7 MHz linear probe, Acuson Antares System, Siemens, Germany) was placed over the TMJ, perpendicular to the zygomatic arch and parallel to the mandibular ramus, and tilted until the best visualization was achieved. When a satisfactory view was obtained, static and dynamic evaluations were performed at different mouth opening positions.

Cortical bone tissues, such as the head of the condyle and the glenoid fossa, are generally hyperechoic (high reflection of sound waves); appearing white on US images, while bone marrow is usually hypoechoic (low reflection of sound waves) and appears black. Connective (joint capsule and rertrodiscal area) and muscular tissues (lateral pterygoid and masseter muscles) are isoechoic (intermediate reflection of sound waves) and appear heterogeneously grey in US images. Empty spaces and water (superior and inferior joint spaces) are hypoechoic (black). The articular disk usually appears as a thin area of hyperechogenity surrounded by a hypoechoic halo.

The double lumen single barrel needle was inserted in a postro-antererior plane with an angulation of 30° and advanced under the capsule until the needle tip appeared to be located into the superior joint space [15]. 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, Fig (2). The time between the puncture and the intra-articular injection as well as the percentage of success of the injection was recorded. A total of 100 ml Ringer lactate solution was used to lavage the superior joint space. During this procedure the mandible was manipulated through opening and closing. Then, needle was withdrawn and area was covered with a dressing moistened with antiseptic solution.

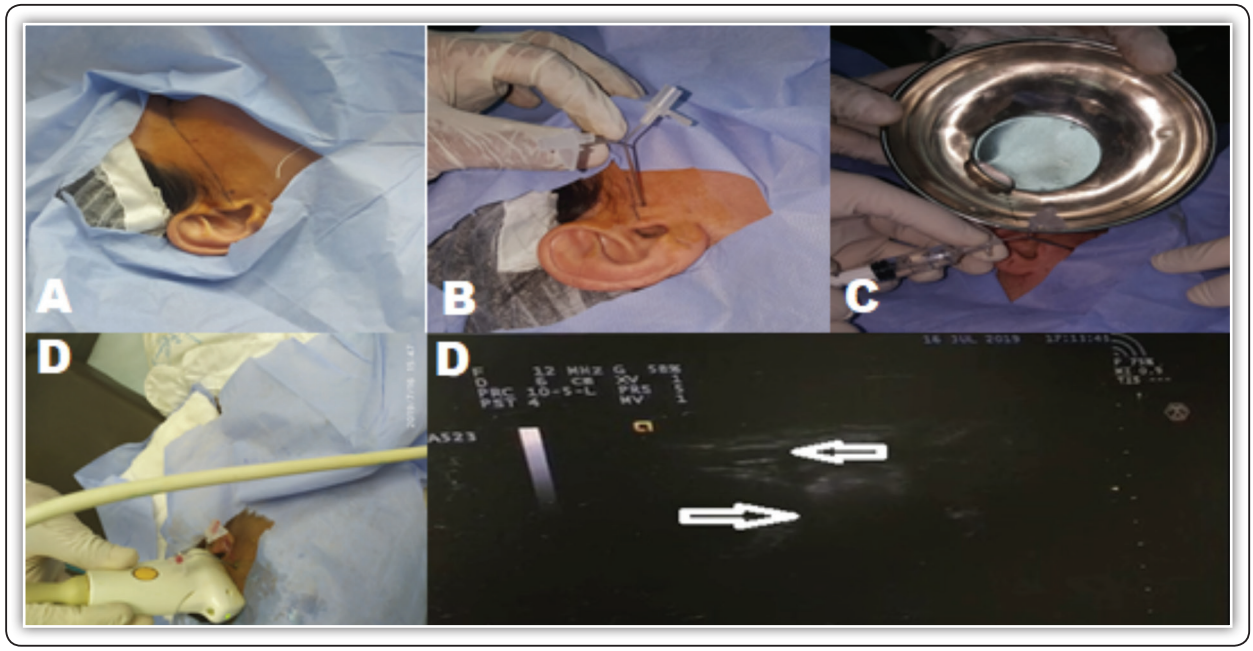

FIG (2) A; Canthotragal line and entrance point marked to the skin, B; needle inserted into the superior joint space in group 1, C; lavage process in group 1, D; needle insertion in group 2, and D; US image in group 2 showing the shadow needle tip located within the superior joint space US image in group 2 showing the shadow needle tip located within the superior joint space.

RESULTS

The present study was performed to Comparison between Ultrasound guided versus conventional single needle arthrocentesis. Eight patients ranged in age between 20.0 – 40.0 years with a mean age of 31.13 ± 6.85years were enrolled in conventional group. Another eight patients ranged in age between 20.0 – 37.0 years with a mean age 29.88 ± 6.01 years were treated with ultra-sound guiding group. There was no statistically significant difference between groups regarding to the mean of age. Conventional group had 4 males and 4 females, while US group had 3 males and 5 females. There was no statistically significant difference between gender distributions in the groups. US group was 1.13±0.35 attempts for needle manipulation while conventional group was 2.75±0.46 attempts for needle manipulation. US group was 12.88±0.99 min in operative procedural time while conventional group was mean 18.75±1.58 min in operative procedural time. US group was successful in 100.0% while conventional group was 62.5% with 12.5% liquid backflow to the needle, 12.5% distension of the TMJ, and 12.5 % liquid outflow form ear. US-guided group: showed a statistically significant decrease in mean degree of pain measurements, from pre-operative to 6 months after treatment. All Results are shown from table 1-5.

TABLE (1) Comparison between the different time periods in each group according to degree of pain:

	Degree of pain												Fr	P
	Pre-operative		1 Week		2 Week		1 month		3 months		6 months			
	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD		
Group I (conventional)	6.60	0.55	2.80	0.45	2.80	0.45	2.60	0.55	2.40	0.55	2.0	0.0	20.600*	0.001*
p_{pre}			0.052		0.052		0.018*		0.005*		<0.001*			
Group II (US-guided)	6.40	0.89	2.40	0.55	2.40	0.55	2.20	0.45	1.80	0.45	1.40	0.55	21.016*	0.001*
p_{pre}			0.052		0.052		0.028*		0.004*		<0.001*			

TABLE (2) Comparison between the different time periods in each group according to maximum mouth opening:

	Maximum mouth opening												F	P
	Pre-operative		1 Week		2 Week		1 month		3 months		6 months			
	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD		
Group I (conventional)	34.0	2.0	38.0	2.0	38.0	0.71	38.00	0.71	38.20	0.45	38.60	1.67	6.802*	0.034*
$p_{Baseline}$			1.000		0.132		0.132		0.094		0.455			
Group II (Ultrasound-guided)	34.20	2.05	39.0	0.0	40.60	1.34	40.80	1.10	41.20	1.10	41.40	1.34	45.280*	<0.001*
$p_{Baseline}$			0.095		0.015*		0.006*		0.001*		0.002*			

TABLE (3) Comparison between the different times in each group according to right maximum excursive movements:

	Right maximum excursive movements												F	P
	Pre-operative		1 Week		2 Week		1 month		3 months		6 months			
	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD		
Right														
Group I	4.0	0.0	5.0	0.0	5.0	0.0	5.60	0.55	5.60	0.55	5.60	0.55	21.926*	0.009*
$p_{Baseline}$			-		-		0.043*		0.043*		0.043*			
Group II	4.80	1.10	4.60	0.55	5.20	0.45	5.60	0.55	5.80	0.84	6.0	0.71	10.214	0.009*
$p_{Baseline}$			1.000		1.000		1.000		1.000		1.000			
Left														
Group I	5.0	0.0	6.0	0.0	6.0	0.0	6.60	0.55	6.60	0.55	6.60	0.55	21.926*	0.009*
$p_{Baseline}$			-		-		0.043*		0.043*		0.043*			
Group II	5.40	0.55	6.0	0.0	6.0	0.0	6.60	0.55	6.60	0.55	6.60	0.55	8.000*	0.026*
$p_{Baseline}$			1.000		1.000		0.490		0.490		0.490			

TABLE (4): Comparison between the two studied groups according topresence or absence of TMJ clicking:

Presence or absence of TMJ clicking	**Group I** (conventional)		**Group II** (Ultrasound-guided)		χ^2	^{FE}p
	No	**%**	**No**	**%**		
1st week						
No	7	87.5	8	100.0	1.067	1.000
Yes	1	12.5	0	0.0		

TABLE (5) Comparison between the two studied groups according to tenderness of TMJ related muscles:

Tenderness of TMJ related muscles	**Group I** (conventional)		**Group II** (Ultrasound-guided)		χ^2	^{FE}p
	No	**%**	**No**	**%**		
1st week						
No	6	75.0	8	100.0	2.286	0.467
Yes	2	25.0	0	0.0		

DISCUSSION

Conservative management is the first treatment option for internal derangement of TMJ, and it has been reported that up to a quarter of the entire population have internal derangements of the TMJ, which are initially treated conservatively. Arthrocentesis is an easy, minimally-invasive, and highly efficient way to decrease pain in the joint and increase the range of mouth opening in patients with closed lock of the TMJ [16, 17]. Nitzan et al described arthrocentesis of the TMJ as the simplest form of treating such dysfunction, as it releases the articular disc and removes adhesions between the disc and the fossa by hydraulic pressure from irrigation of the

upper chamber of TMJ. Considerable improvements in pain and mouth opening have been reported with confirmed long-term results after arthrocentesis [18].

Şentürk et al, mentioned that conventional "blind" technique to reach the upper joint space requires experience, and carries a risk of damage to the collateral ligaments and the adjacent soft tissue. Ultrasound (US) scanning is an effective way to guide the placement of the needle into the joint space allowing lysis and lavage of the TMJ permitting real-time dynamic arthrocentesis [19].

In the present study, eight patients ranged in age between 20.0 – 40.0 years with a mean age of 31.13 ± 6.85years for conventional group and eight patients ranged in age between 20.0 – 37.0 years with a mean age 29.88 ± 6.01 years for US group. There was no statistically significant difference between groups regarding to the mean of age. Conventional group had 4 males and 4 females, while US group had 3 males and 5 females. There was no statistically significant difference between gender distributions in the groups.

All patients were evaluated clinically at (one week, two weeks, one month, 3 months and 6 months) postoperatively for the following: Pain; through visual analogue scale (VAS), maximum mouth opening (MMO) with ruler in millimeters, right and left maximum excursive movements with ruler in millimeters, TMJ clicking and tenderness of TMJ related muscles, attempts for needle manipulation, operative procedural time and accuracy.

Olsen-Bergem and Bjornland [20] used US for a closed, single-needle system procedure in 21 patients and reported satisfactory results for pain in an 8-month follow-up. Wiler et al [21] found that US-guided arthrocentesis did not significantly increase the yield of fluid. They found that use of a guided approach created no more pain. Ultrasonography is relatively inexpensive compared with MRI and cone-beam CT, and yields real-time images that permit dynamic assessment. The devices are portable and mobile, which allows evaluation of both joints. Sibbitt et al. reported that US-guided arthrocentesis caused significantly less procedural pain, more successful diagnoses, more synovial fluid, more complete decompressions of the joint, and improved clinical outcomes [22].

At 2 weeks, 1, 3, and 6 months: there was a statistically significant difference between mouth opening in the two groups. Ultrasound-guided group showed a high maximum mouth opening. Olsen-Bergem and Bjornland [20] · used US for a closed, single-needle system procedure in 21 patients and reported satisfactory results MMO in an 8-month follow-up.

Group I (conventional) after one week only one patient remained with clicking while Group II (Ultrasound-guided) showed no clicking after one week. Group I (conventional) after one week only two patients remained with tenderness while Group II (Ultrasound-guided) showed no tenderness after one week. Group I (conventional) and Group II (Ultrasound-guided) pre procedure all patients had diseased disc position. After 6 months Group I (conventional) showed improved 6 patients and 2 patients showed no change while Group II (Ultrasound-guided) showed improved 7 patients and only 1 patients showed no change. Group I (conventional) and Group II (Ultrasound-guided) pre procedure all patients had diseased osseous and soft tissue components of TMJ area. After 6 months Group I (conventional) showed improved 6 patients and 2 patients showed no change while Group II (Ultrasound-guided) showed improved 7 patients and only 1 patients showed no change.

US group take mean 32.13 ±1.46 min in total operative procedural time while conventional group took mean 40.38 ±1.77 min in total operative procedural time. The difference was statistically significant. US group showed a less total operative procedural time ($p<0.001^{*}$). In contrast, Sivri et al [23] · compared the effectiveness of the two techniques. US-guided arthrocentesis took significantly longer

time than the conventional technique, at the start of this study; by going on the time factor became in favor of the US-guided group.

Bhargava et al [24] assist needle insertion for temporomandibular joint arthrocentesis using ultrasonography. None of the patients in either group developed any complication with no significant difference in VAS score for pain between the two study groups. The number of attempts for needle manipulation (mean ± SD) for conventional group was 2.20 ± 0.789, and for US group, it was 1.10 ± 0.316 (p value, 0.0007). In the present study, the number of attempt needle manipulations was while that of conventional group was 2.75 trials. The difference reflects the difference between blind and direct vision manipulations. US-guidance could be a useful method during puncture of the joint space, allowing a direct visualization of the needle throughout its course to the joint with a high accuracy.

Operative procedural time (mean ± SD) for conventional group was 18.5 ± 3.171 min, and for US group, it was 13.1 ± 1.663 (p value, 0.0002) which was significantly lesser in conventional group than in US group. Ultrasound-guided single-puncture arthrocentesis using a customized needle is a promising method to perform joint lavage with minimal trauma and in a precise manner.

Wiler et al [21] found that US-guided arthrocentesis did not significantly increase the yield of fluid. They found that use of a guided approach created no more pain and required no more time than a standard technique. Cunnington et al. found that use of a US-guided technique significantly improved the accuracy of intra-articular injections, but not the outcomes of the injections [15].

Ultrasonography is relatively inexpensive compared with MRI and cone-beam CT, and yields real-time images that permit dynamic assessment. The devices are portable and mobile, which allows evaluation of both joints. Sibbitt et al [22] reported that US-guided arthrocentesis caused significantly less procedural pain, more successful diagnoses, more synovial fluid, more complete decompressions of the joint, and improved clinical outcomes. Total procedural time and attempts to relocate the needle affect postoperative outcomes. Shorter operating times and fewer attempts at puncture reduce postoperative pain and swelling.

Regarding accuracy, US group was Successful in 100.0 % while Conventional group was 62.5 % with 12.5 % Liquid backflow to the needle, 12.5 % Distension of the TMJ, and 12.5 % Liquid outflow form ear. The presence of a backflow of fluid associated with the distention of the joint cavity is observed only in case of intraarticular 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 91% [25]. They estimated indirectly the success of the injection by visualization of the needle tip on CT images [26]. Sivri et al. 2016 used the backflow of fluid as a confirmation of intra-articular injection [27].

We found that the US-guided approach allowed correct ınsertion of the needle for six patients at the first attempt, for two at the second attempt. The US- guided technique also took longer than the conventional techniques. Although to gain access to the joint space takes up most of the operating time, the total time was longer when the US-guided method was used, because US examination alone requires extra time. We conclude that US-guided arthrocentesis of the TMJ was more successful than the conventional technique, and took longer. Further studies with more patients are required to validate these findings.

CONCLUSIONS

Maximal mouth opening improved with conventional and US guided arthrocentesis. Successive increase in maximal mouth opening was observed during follow up periods. MRI

findings indicated that there was no change in disc position even after improvement of mouth opening. US-guided technique significantly improved the accuracy of intra-articular injections, but not the outcomes of the injections.

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