



## **THE EFFECT OF COMBINING CORTICOSTEROIDS AND HYALURONIC ACID, AS OPPOSED TO THAT OF CORTICOSTEROIDS ALONE, FOLLOWING TEMPOROMANDIBULAR JOINT ARTHROCENTHESIS.**

Sherif Assem Hussein\*, Ibrahim Ezzat Shindy\*\* and Mohamed Hassan Ahmed\*\*\*

### **ABSTRACT**

**Objective:** The purpose of this study is to evaluate the therapeutic effect of the combination of Hyaluronic acid and Corticosteroids in treatment of Temporomandibular joint disorder following Temporomandibular arthrocenthesis using single needle technique.

**Materials and Methods:** 12 young females that have been diagnosed for internal derangement of the Temporomandibular joint, were divided into two groups where the first group (Study group) were treated by a combination of Hyaluronic acid and Corticosteroids following TMJ arthrocenthesis. While the second group (Control group) were treated only by Corticosteroids.

All procedures were performed using single needle technique and took place at the outpatient clinic of the Oral and Maxillofacial Department, Faculty of Oral and Dental Medicine, Cairo University.

**Results:** The study showed a remarkable decrease in pain sensation and increase in range of mouth opening in the majority of the cases.

### **Conclusion:**

- Single needle arthrocenthesis is an effective technique for treatment of internal derangement of the TMJ.
- The mix of hyaluronic acid and corticosteroid did not show any significant difference when compared to the injection of corticosteroids alone in mouth opening and VAS score.
- Psychological stresses have a negative effect on temporomandibular condition, and the effectiveness of the treatment procedure.

**KEYWORDS:** Temporomandibular joint, Arthrocenthesis, Lavage, Hyaluronic acid, Corticosteroid, Single needle.

---

\* B.D.S Faculty of Oral and Dental Medicine, Cairo University 2005.

\*\* Professor of Oral and Maxillofacial Surgery, Cairo University.

\*\*\*Lecturer of Oral and Maxillofacial Surgery, Cairo University.

## INTRODUCTION

Temporomandibular joint disorders are a heterogeneous group of diseases that cause progressive joint degeneration leading to chronic pain and reduced quality of life. Both effective pain reduction and restoration of TMJ function remain a challenge.<sup>1</sup>

Internal derangement has been described as a progressive disorder with a normal history that may be classified into four consecutive clinical stages.<sup>2,3</sup> Stage one has been described as disk displacement with reduction. Stage two as disk displacement with reduction and intermittent locking. Stage three as disk displacement without reduction (closed lock) and Stage four as disk displacement without reduction and with perforation of the disk or posterior attachment tissue.

Many conservative treatment approaches have been proposed throughout the years, among which are occlusal splints therapy<sup>4,5</sup>, physiotherapy<sup>6,7</sup>, pharmacotherapy<sup>8,9</sup> and occlusal treatments<sup>10</sup>.

TMJ arthrocentesis developed from the great success of TMJ arthroscopic lysis and lavage<sup>11,12</sup>, as well as pumping irrigation of the upper joint space<sup>13</sup>, in treating patients with temporomandibular closed lock<sup>14,15</sup>. The success of these procedures was compelling in that they are not primarily meant to change disk position or shape<sup>16,17</sup>, but due to the physical action of lysis and lavage in the upper joint space<sup>18</sup>. To enhance the outcome of arthrocentesis, post operative intra-articular injection of various substances were used regarding their analgesic, anti-inflammatory and lubrication properties. Local anesthetics<sup>19,20</sup>, morphine<sup>20</sup>, corticosteroids<sup>21</sup>, sodium hyaluronate, tenoxicam, celecoxib<sup>20</sup> and piroxicam were introduced as treatment modalities.

The presented study was concerned with the treatment of patients with internal derangement of the temporomandibular joint by arthrocentesis with normal saline, corticosteroids and hyaluronic acid as an intra-articular drug injection.

Temporomandibular disorders are defined as a subgroup of craniofacial pain problems that involve the TMJ, masticatory muscles and associated head and neck musculoskeletal structures. Patients with temporomandibular disorders most commonly experience pain, limited or asymmetric mandibular motion, and TMJ sounds<sup>22</sup>. The pain is localized to the jaw, TMJ and muscles of mastication. Symptoms may also include ear pain, tinnitus, dizziness, neck pain and headache.

The prevalence among adults in the United States of America with at least one sign of temporomandibular disorders is reported 40% to 75%, and among those with at least one symptom 33%<sup>23,24,25</sup>. TMJ sounds and deviation on opening the jaw occur in approximately 50% of otherwise asymptomatic persons; these are considered within the range of normal and do not require treatment<sup>26</sup>. Other signs such as decreased mouth opening and occlusal changes occur in fewer than 5% of the general population<sup>27</sup>. Temporomandibular disorders are most commonly reported in young to middle aged adults (20 to 50 years of age). The female to male ratio of patients seeking care has been reported as ranging from 3:1.

Despite the high prevalence of temporomandibular disorders, signs and symptoms, only 5 to 10% of those with symptoms require treatment, given the history of this disorder 40% of patients the symptoms will resolve spontaneously<sup>23,29</sup>. With regard to clinical diagnosis and treatment, two predominant stages of disc derangements are distinguished. The respective conditions are called disc derangement with reduction and disc derangement without reduction. IDWR is typically defined as a condition in which the articular disc of the TMJ is (most often anteriorly) displaced while the mouth is closed and the teeth are together in maximal occlusion. IDWOR is defined as a condition in which the condyle is unable to slide or snap back underneath the disc. The (anteriorly) displaced disc thus does not reduce to its position on top of the condyle during the opening movement. In the late stages

of disk displacement without reduction, the disk is deformed and has a stretched, torn, or detached posterior attachment: communication between the upper and lower joint spaces (perforation) are often seen<sup>30-33</sup>. Most commonly the perforations are found in the posterior disk attachment, at its junction with the disk itself.

The aim of definitive treatment for disk displacement is to reestablish proper condyle-disk relationship and more reasonably elimination of pain and limitation in movements<sup>29</sup>. Treatment methods can be divided into: Non surgical treatment modalities which includes: Occlusal splints, Physiotherapy and Pharmacotherapy. And the surgical treatment which includes: the minimally invasive procedures such as arthroscopy and arthrocentesis, and major surgical interventions<sup>62</sup> such as disk repair and discectomy.

Arthrocentesis as a first-line procedure for acute and chronic "closed lock" of the temporomandibular joint (TMJ) is a simple, minimally invasive, and effective procedure with proven long-term results and minimal potential complications. It is commonly defined as a lysis and lavage of the joint and is traditionally accomplished without viewing the joint. Lavage of the upper joint space reduces pain by removing inflammatory mediators from the joint<sup>35,36</sup>.

The most common technique is the two needle arthrocentesis of the TMJ which provides a double access to the joint space. Such an access is performed by taking as indicator the Holmlund line which extends from the mid tragus of the ear to the lateral canthus of the eye and two 19G needles are placed within a small virtual cavity. Where the first needle is placed at 10-12 mm from the mid tragus and 2 mm below that point as an inlet needle and the other needle is placed at 22 mm from the mid tragus and 10 mm below that point as an outlet needle. The articular lavage is performed in a single session through the injection of 300 ml of Ringer lactate solution or normal saline, which is the

needed amount of fluid to remove catabolytes<sup>37</sup>. The positioning of two needles within a small cavity like the TMJ may cause some discomfort to patients, particularly at the time of the first lavage<sup>38</sup>. The introduction of single needle technique was intended to improve the tolerability of TMJ arthrocentesis. Moreover, the insertion of a single needle reduces the risks of Facial nerve injury.

The aim of the study was to evaluate the effect of combination of corticosteroids and hyaluronic acid in comparison to corticosteroids alone following TMJ arthrocentesis in patients with internal derangement without reduction in the temporomandibular joint, using single needle technique.

## MATERIAL AND METHOD

The study was conducted on 12 female patients that were randomly selected from the outpatient clinic of the Oral and Maxillofacial Surgery Department, Faculty of Oral and Dental Medicine, Cairo University. The selected patients were asked to go through a full clinical history and examination that was documented in a specific chart. The patients were divided randomly into two groups:

**Group A:** (Study Group) Consisted of six patients treated using a combination of Hyaluronic Acid and Corticosteroid following TMJ arthrocentesis.

**Group B:** (Control Group) Consisted of six patients treated using corticosteroid alone following TMJ arthrocentesis.

All the selected sample of patients was young adult females with history of limited mouth opening and/or pain confined to the temporomandibular joint. The patients were examined extraorally for pain or tenderness and movement of the TMJ, also muscles of mastication were palpated to detect any signs of pain and tenderness, the patient was asked to rate the pain that he experienced during the examination in VAS score. Inter-incisal mouth opening and lateral excursion were recorded. Intraoral examination of dentition to detect malocclusion, attrition and interference of movement.

The selected patients received a series of 2 intra-articular injections spaced 2 weeks apart. Arthrocentesis followed by intra-articular injection was performed in the first visit; intra-articular injection without arthrocentesis was performed in the second visit.

Local anesthesia (Septanest SP) was injected using Auriculotemporal nerve block technique, and preauricular infiltration anesthesia. A 16 gauge metal cannula was inserted in the point of entry, the patient was asked to open and close her mouth. Simultaneous movement of the cannula with opening and closing indicates positioning of the cannula in the superior joint space.

A 5ml plastic syringe is used to inject 2mm of normal saline solution to distend the superior joint space where resistance to inflow and ejection after syringe removal confirms the correct position of the cannula in the superior joint space. The injection-ejection process was performed for up to 20 repetitions (for a total of 40ml of normal saline solution).

Intra-articular injection was performed by mixing Hyalgan and Dexamethasone (1:1 ratio) using 1 ml of the mixture for injection in the study group; and injection of 1ml of Dexamethasone for the control group. On the second recall visit, pre-operative measurements are taken the same way as the first visit, and injection of the active material takes place but not proceeded by arthrocentesis.

Post-operative instructions and medications were given to the patients after the termination of the session. All patients were evaluated on the intervals of 2,4,6,8 and 12 weeks after the second visit.

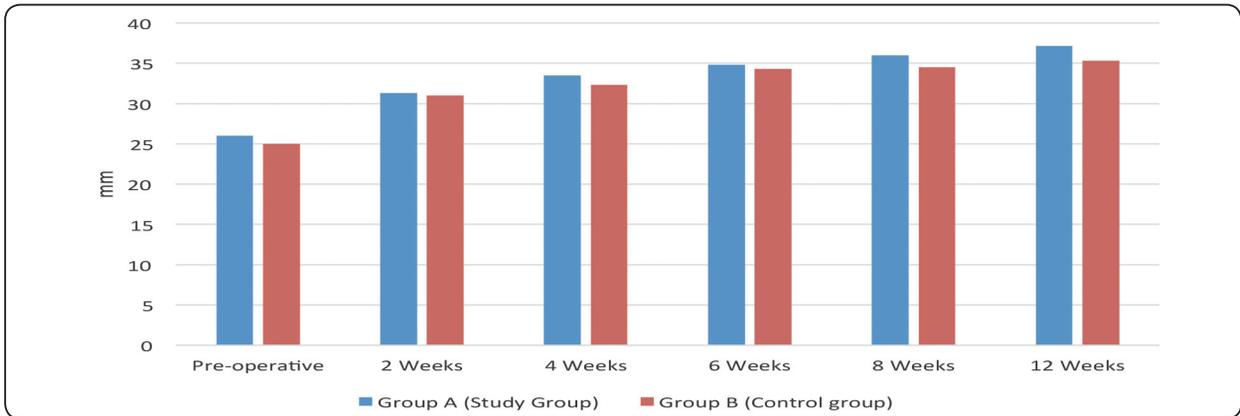
## RESULTS

### Mouth Opening

The study showed that there was no significant difference in the inter-incisal mouth opening of both groups all over the entire follow up visits.

TABLE (1) Mean and standard deviation (SD) of Inter-incisal mouth opening for different groups.

Follow up visits	Mean $\pm$ SD IMO (mm)		p-value*
	Group A (study group)	Group B (Control group)	
Pre-operative	26.00 $\pm$ 2.76	25.00 $\pm$ 2.72	0.937
2 Weeks postoperative	31.33 $\pm$ 2.80	31.00 $\pm$ 5.55	0.818
4 Weeks	33.50 $\pm$ 2.43	32.33 $\pm$ 5.32	0.818
6 Weeks	34.83 $\pm$ 3.49	34.33 $\pm$ 4.97	1.00
8 Weeks	36.00 $\pm$ 4.00	34.50 $\pm$ 4.28	0.589
12 Weeks	37.17 $\pm$ 3.87	35.33 $\pm$ 4.37	0.589

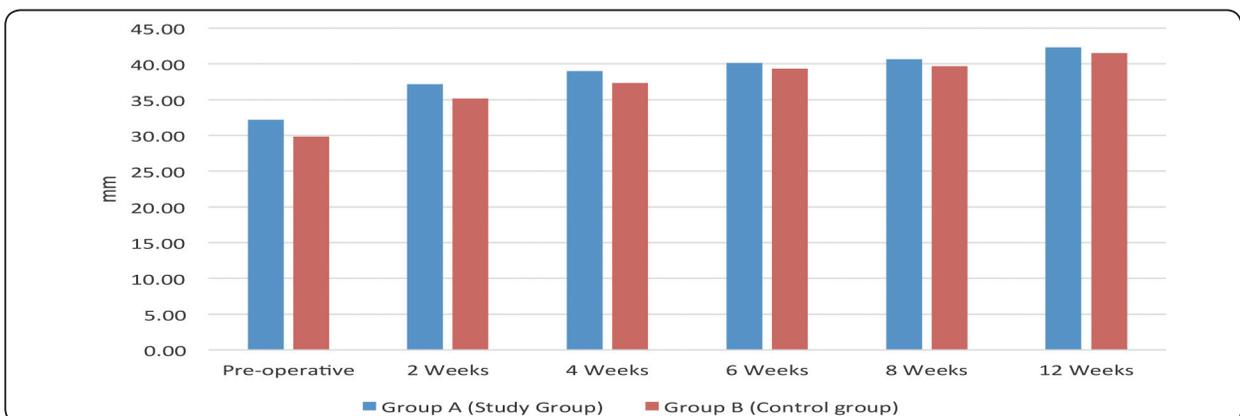


Histogram showing the mean Inter-incisal mouth opening of different groups for different follow-up periods.

**Assisted Mouth Opening**

The study showed no significant difference in the assisted inter-incisal mouth opening between the different groups all over the follow up visits.

Follow up visits	Mean ± SD IMO (mm)		p-value*
	Group A (study group)	Group B (Control group)	
Pre-operative	32.17± 2.32	29.83±8.28	0.598
2 Weeks postoperative	37.17±2.14	35.17±5.08	0.699
4 Weeks	39.00±2.53	37.33±5.35	0.818
6 Weeks	40.17±2.40	39.33±3.83	0.937
8 Weeks	40.67±2.80	39.67±4.08	0.818
12 Weeks	42.33±3.39	41.50±3.83	0.699

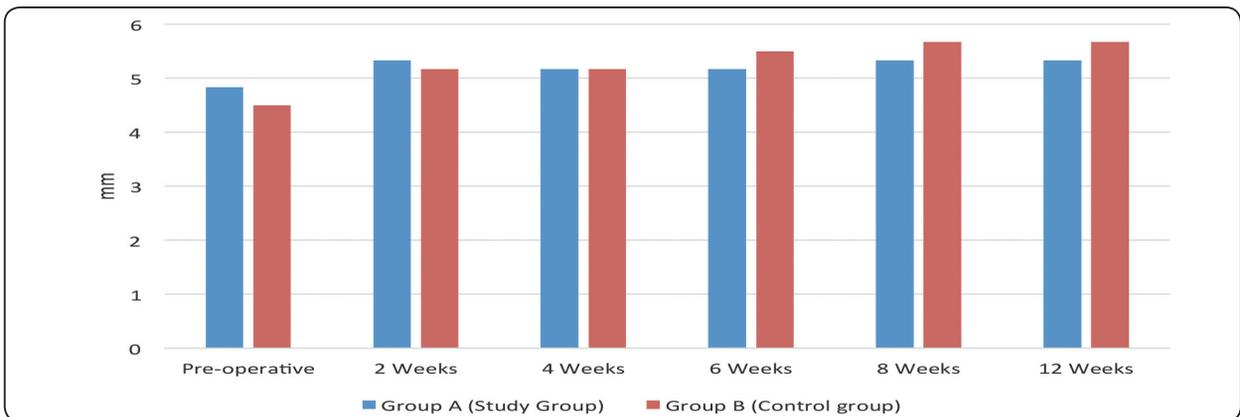


Histogram showing the mean Assisted Inter-incisal mouth opening of different groups for different follow-up periods.

**Lateral Mouth Movement**

The study showed no significant difference in the lateral mouth opening in the two groups all over the follow up visits.

Follow up visits	Mean ± SD IMO (mm)		p-value*
	Group A (study group)	Group B (Control group)	
Pre-operative	4.83± 1.17	4.50±0.84	0.598
2 Weeks postoperative	5.33±0.82	5.17±0.75	0.699
4 Weeks	5.17±0.75	5.17±0.75	1.00
6 Weeks	5.17±0.98	5.50±0.55	0.699
8 Weeks	5.33±0.82	5.67±0.52	0.589
12 Weeks	5.33±0.82	5.67±0.52	0.589

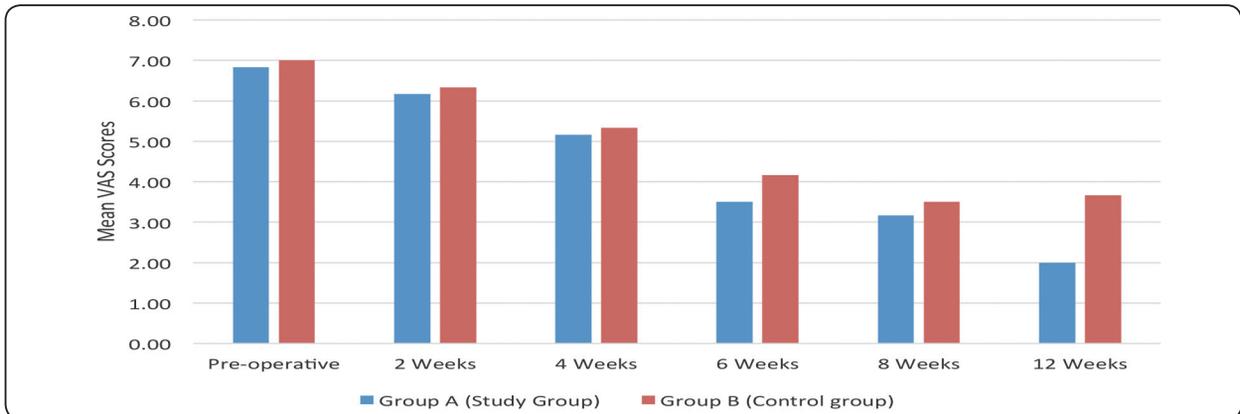


Histogram showing the mean Lateral mouth opening of different groups for different follow-up periods.

**VAS Scores**

The study showed no significant difference in the VAS score in the two groups all over the follow up visits.

Follow up visits	Mean ± SD IMO (mm)		p-value*
	Group A (study group)	Group B (Control group)	
Pre-operative	6.83± 0.75	7.00±1.26	0.699
2 Weeks postoperative	6.17±1.47	6.33±2.73	0.589
4 Weeks	5.17±1.33	5.33±3.27	0.818
6 Weeks	3.50±0.55	4.17±3.31	0.394
8 Weeks	3.17±0.98	3.50±3.02	0.699
12 Weeks	2.00±1.55	3.67±2.88	0.310



Histogram showing the mean VAS Scores of different groups for different follow-up periods.

## DISCUSSION

The present study compared clinically the efficacy of injection of a mix of hyaluronic acid and corticosteroids (study group) versus the injection of corticosteroids alone (control group) following TMJ arthrocentesis for the treatment of cases diagnosed with anterior displaced disk without reduction. There was no significant difference between both the study and control groups as regarding range of mouth motions and visual analogue scale score improvement.

Inter-incisal mouth opening showed significant improvement in both groups after 12 weeks post-operatively to reach  $37.17 \pm 3.87$  mm in the study group, and  $35.33 \pm 4.37$  mm in the control group with no significant difference between them ( $p$  value=0.589). Lateral jaw movement showed insignificant increase to  $5.33 \pm 0.82$  mm in the study group and significant increase to  $5.67 \pm 0.52$  mm in the control group. On the other hand, VAS score showed a significant decrease in both groups to reach  $2 \pm 1.55$  in the study group and  $3.67 \pm 2.88$  in the control group.

Previous studies done by *Manfredini et al.*<sup>39</sup>, *Moystad et al.*<sup>40</sup>, *Kopp S et al.*<sup>41</sup>, and *Paschalia et al.*<sup>42</sup>, and by *Yeung*<sup>43</sup> held a comparison between hyaluronic acid and corticosteroid, and these studies

did not show a significant difference between different groups.

In the current study, the combination of Hyaluronic acid together with Corticosteroid was aiming to benefit from the anti-inflammatory effect of the corticosteroids and the lubrication effect of Hyaluronic acid. This combination was compared to the injection of corticosteroids.

Lateral jaw movement showed insignificant increase to  $5.33 \pm 0.82$  mm in the study group and significant increase to  $5.67 \pm 0.52$  mm in the control group.

*Pramila Shayka et al.*<sup>43</sup> showed in the study of efficacy of arthrocentesis with injection of hyaluronic acid in the treatment of internal derangement of the TMJ, lateral jaw movement increased from mean  $5 \pm 2.09$  to  $6.80 \pm 1$  mm and the result was significant. This may be due to the higher preoperative values of lateral jaw movements, which lead to higher post-operative improvements.

The degree of improvement of mean VAS in the study group (70%) was different from those shown by *Guarda-Nardini et al.*<sup>44</sup> (47%). In the current study, the preoperative mean VAS was  $6.83 \pm 0.75$  while that of *Guarda-Nardini et al.* study was  $2.90 \pm 3.12$  which affected the overall improvement. This difference may be due to the inclusion of

cases having disk displacement with reduction to *Guarda-Nardini et al.* study in contrast that of the current study where cases without reduction were only included.

The current study showed a success rate of 91% which was similar to the results shown by Nitzan et al.<sup>122</sup> who also described high success rate of 91% though utilizing double needle technique. Which means that the use of single needle technique is more justified than the double needle technique to benefit from its advantage.

The study was restricted only to female patients to exclude the female hormonal effect on the intensity of pain reflected by the patient. This hormonal effect was proven by the study done by *Renata Cunha Matheus* and *Rodrigues Garcia*.<sup>46</sup>, which concluded that the presence of estrogen may exert a stronger influence on temporomandibular disorders compared to the hormone's cyclic variations across the menstrual cycle.

The highest improvement of range of mouth movements and mean VAS took place in two weeks postoperatively. This indicates the rapid effect of arthrocentesis on cases diagnosed with anterior disk displacement, which might be due to its actions: Removing intra-articular adhesions, eliminating the negative pressure within the joint, removal of inflammatory mediators, recovering disk and fossa space, and improving disk mobility.

## CONCLUSION

Single needle arthrocentesis is an effective technique for treatment of internal derangement of the TMJ.

The mix of hyaluronic acid and corticosteroid did not show any significant difference when compared to the injection of corticosteroids alone in mouth opening and VAS score.

Psychological stresses have a negative effect on temporomandibular condition, and the effectiveness of the treatment procedure.

## REFERENCES

1. Paschalia M, Mountziaris, Philip R, Kramer, Antonios G. Mikos: Emerging intra-articular drug delivery systems for the temporomandibular joint. NIH-PA Author Manuscript 47 (2): 134, 2009.es.
2. Dolwiczek MF, Katzberg RW, Helms CA.: Internal derangement of the temporomandibular joint: Fact or fiction? J Prosthet Dent 1983; 49:415-8.
3. Heffez L.: Surgery for internal derangement of the temporomandibular joint. In: Peters L, Indresano T, Marciani R, Roser S, editors. Principles of oral and maxillofacial surgery. Philadelphia: J.B. Lippincott; 1992.p. 1933-5
4. Dao TT, Lavigne GJ.: Oral splints: the crutches for temporomandibular disorders and bruxism? Crit Rev Oral Biol Med 1998; 9:345-61.
5. Turp JC, Komine F, Hugger A.: Efficacy of stabilization splints for the management of patients with masticatory muscle pain: a qualitative systematic review. Clin Oral Investig 2004; 8:179-95.
6. Nicolakis P, Erdogmus CB, Kollmitzer J, Kerschman-Schindl K, Sengstbratl M, Nuhr M, et al.: Long term outcome after treatment of temporomandibular joint osteoarthritis with exercise and manual therapy. Cranio 2002; 20:23-7.
7. Nicolakis P, Erdogmus CB, Kopf A, Nicolakis M, Pichslinger E, Fiala-Moser V.: Effectiveness of exercise therapy in patients with myofascial pain dysfunction syndrome. J Oral Rehabil 2002; 29:362-8.
8. Dionne RA.: Pharmacologic treatments for temporomandibular disorders. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1997; 83:134-42.
9. Manfredini D, Romagnoli M, Cantini E, Bosco M.: Efficacy of tizanidine hydrochloride in the treatment of myofascial face pain. Minerva Med 2004; 95:165-71.
10. LeBell Y, Niemi PM, Jasma T, Kylmala M, Alanen P.: Subjective reactions to interventions with artificial interferences in subjects with and without a history of temporomandibular disorders. Acta Odontol Scand 2006; 64:59-63.
11. Nitzan DW, Dolwiczek MF, Heft MW.: Arthroscopic lavage and lysis of the temporomandibular joint: a change in perspective.
12. Sanders B.: Arthroscopic surgery of the temporomandibular joint: treatment of internal derangement with persistent closed lock. Oral Surg Oral Med Oral Pathol 1986; 62: 361-372. J Oral Maxillofac Surg 1990;48: 798-801.
13. Murakami KI, Iizuka T, Matsuki M, Ono T.:Recapturing the persistent anteriorly displaced disk by mandibular

- manipulation after pumping and hydraulic pressure to the upper joint cavity of the temporomandibular joint. *Cranio* 1987; 5:17–24.
14. Dolwick MF, Dimitroulis G.: Is there a role for temporomandibular joint surgery? *Br J Oral Maxillofac Surg* 1994;32: 307–313.
  15. Frost DE, Kendell BD. Part II: The use of arthrocentesis for treatment of temporomandibular joint disorders. *J Oral Maxillofac Surg* 1999; 57: 583–587.
  16. Gabler MJ, Greene CS, Palacios E, Perry HT.: Effect of arthroscopic temporomandibular joint surgery on articular disk position. *Craniomandib Disord* 1989; 3: 191–202.
  17. Nitzan DW, Dolwick MF, Heft MW.: Arthroscopic lavage and lysis of the temporomandibular joint: a change in perspective. *J Oral Maxillofac Surg* 1990;48: 798–801.
  18. Carvajal WA, Laskin DM.: Long-term evaluation of arthrocentesis for the treatment of internal derangements of the temporomandibular joint. *J Oral Maxillofac Surg* 2000; 58: 852–855.
  19. Zuniga JR, Ibanez C, Kozacko M: The analgesic efficacy and safety of intra-articular morphine and mepivacaine following temporomandibular joint arthroplasty. *Int Journal Oral and Maxillofacial Surgery*. 2007 36:922-927.
  20. Scott S, Neil R, Connelly R: Postoperative analgesia for outpatient arthroscopic knee surgery with intra-articular bupivacaine and ketorolac. *Anaesth Analg* 1995; 80:1154-7.
  21. Freriksson L, Alstergren P, Kopp S: Tumor necrosis factor- $\alpha$  in temporomandibular joint synovial fluid predicts treatment effects on pain by intra-articular glucocorticoid treatment. *Mediators of inflammation* 2006; 6:59425.
  22. Brennan PA, Ilankovan V: Arthrocentesis for temporomandibular joint pain dysfunction syndrome. *J Oral Maxillofacial Surg* 2006; 64:949-951.
  23. Quinn JH, Kent JN, Noise A, Lukiw WJ: Cyclooxygenase-2 in the synovial tissue and fluid of dysfunctional temporomandibular joints with internal derangement. *J Oral Maxillofac Surg* 2000; 58:1229-1232.
  24. Ogasawara T, Kitagawa Y, Ogawa T, Yamada T, Kawamura Y, Sano K: Inflammatory change in upper joint space in the temporomandibular joint with internal derangement on Gadolinium-enhanced MR imaging. *Int J Oral Maxillofac Surg* 2002; 31:252-256.
  25. Miyamoto H, Sakashita H, Miyata M: Arthroscopic surgery of the temporomandibular joint: Comparison Of two successful techniques. *Br J Oral Maxillofac Surg* 1999; 37:397.
  26. Dhaif G, Ali T: TMJ arthrocentesis for acute closed lock: Retrospective study of 40 consecutive cases. *Saudi Dental Journal* 2001; 13:123-127.
  27. Alpaslan C, Dolwick MF, Heft MW: five year retrospective evaluation of temporomandibular joint arthrocentesis. *Int J Oral Maxillofac Surg*. 2003; 32:263-267.
  28. Abu-Bakr O: Oral and Maxillofacial surgery secrets. 2001, chapter 30:233.
  29. Okeson: Temporomandibular disorders and occlusion. Mosby. Fifth edition,
  30. Wilkes CH. Internal derangements of the temporomandibular joint. Pathological variations. *Arch Otolaryngol Head Neck Surg* 1989;115:469-477.
  31. Westesson PL, Bronstein SL, Liedberg J.: Internal derangement of the temporomandibular joint: morphologic description with correlation to function. *Oral Surg oral Med oral Pathol* 1985; 59:323-331.
  32. Wilkes CH.: Structural and functional alterations of the temporomandibular joint. *Northwest Dent* 1978; 57:287-294.
  33. Westesson Pl.: Structural hard-tissue changes in temporomandibular joints with internal derangement. *Oral Surg Oral Med Oral Pathol* 1985; 59:220-224.
  34. Fonseca RJ.: Oral and maxillofacial surgery, temporomandibular joint disorders, W B Saunders. Philadelphia, Pennsylvania, 1st edition, 2000.
  35. Quinn JH, Bazan NG: Identification of prostaglandin E2 and Leukotriene B4 in the synovial fluid of painful, dysfunctional temporomandibular joints. *J Oral Maxillofac Surg*. 1990 Sep; 48(9):968-71.
  36. Spallaccia F, Rivaroli A, Cascone P.: Temporomandibular joint arthrocentesis: long term results. *Bull Group Int Rech Sci Stomatol Odontol*. 2000 Jan-Apr; 42(1):31-7.
  37. McCain JP, Balazs EA, de la Rúa H: Preliminary studies on the use of a viscoelastic solution in arthroscopic surgery of the temporomandibular joint. *J Oral Maxillofac Surg* 47:1161, 1989.
  38. Luca Guarda-Nardini, Daniele Manfredini, Giuseppe Ferronato: Arthrocentesis of the temporomandibular joint: a proposal for a single needle technique. (*Oral Surg Oral Med Oral Pathol Oral Radiol Endod*) 106:483, 2008.
  39. Manfredini D, Bonini S, Arboretti R, Guarda-Nardini L : Temporomandibular joint osteoarthritis: an open label trial of 76 patients treated with arthrocentesis plus hyaluronic acid injections. *Int J Oral Maxillofac Surg* 2009; 38:827-834.

40. Moystad A, Mork-Knutsen BB, Bjornland T.: Injection of sodium hyaluronate compared to a corticosteroid in the treatment of patients with temporomandibular joint osteoarthritis: a CT evaluation. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2008;105:e53–e60.
41. Kopp S, Wenneberg B, Haraldson T, Carlsson GE. Long-term effect of intra-articular injections of sodium hyaluronate and corticosteroid on temporomandibular joint arthritis. *J Oral Maxillofac Surg* 1985;43:429–435.
42. Paschalis M, Mountziaris a, Phillip R, Kramer b, Antonios G, Mikos a.: Emerging intra-articular drug delivery systems for the temporomandibular joint. *Methods* 47 (2009) 134–140.
43. Yeung RW.: Short term outcome of intra-articular high molecular weight hyaluronic acid injection for non reducing disc displacement of the temporomandibular joint. *Oral Surg Oral Med Oral Pathol Oral Radiol Endol* 2006; 102:453-61.
44. Luca Guarda-Nardini, Daniele Manfredini, Giuseppe Ferronato: Short term effects of arthrocentesis plus viscosupplementation in the management of signs and symptoms of painful TMJ disk displacement with reduction. A pilot study, October 2009.
45. Nitzan DW, Dolwick MF, Martinez GA.: Temporomandibular joint arthrocentesis: a simplified treatment for severe, limited mouth opening. *J Oral Maxillofac Surg* 1991; 49:1163-1167.
46. Renata Cunha Matheus Rodrigues Garcia: Effect of female hormones on pain sensitivity, bite force and masticatory performance of TMD patients. *International Journal of Prosthodontics*; v.24, n.4, p.320-327, JUL-AUG 2011.