



ORIGINAL ARTICLE

A prospective study of 138 arthroscopies of the temporomandibular joint^{☆,☆☆}



Paulo Alexandre da Silva^{a,*}, Maria Teresa de Fatima Fernandes Lopes^b,
Fernando Silva Freire^b

^a Department of Oral and Maxillofacial Surgery and Traumatology (OMFST), Medical Center, Hospital Vivalle São José dos Campos, São José dos Campos, SP, Brazil

^b Departament of Oral and Maxillofacial Surgery and Traumatology, Instituto Educacional de Ciências da Saúde (IECS Facsete/Ciodonto), Sete Lagoas, MG, Brazil

Received 25 August 2013; accepted 31 August 2014
Available online 9 June 2015

KEYWORDS

Arthroscopy;
Temporomandibular joint;
Temporomandibular joint disorders;
Temporomandibular joint dysfunction syndrome;
Temporomandibular articular disk

Abstract

Introduction: Internal derangements (ID) of the temporomandibular joint (TMJ) have a multifactorial etiology and are most often treated conservatively by splints, physical therapy and medications. Only in 2–5% of cases are the treatment surgical, either by arthroscopy or arthrotomy.

Objective: To evaluate improvement of mouth opening, pain relief during function, position of the articular disk and complications following Arthroscopic Lyse and Lavage (ALL).

Methods: A prospective study of 78 patients (138 TMJs) with TMJ ID, 5 males and 73 females, mean age 29.7 years, treated between January 2010 and April 2013, who were refractory to conservative treatment, had limited mouth opening and pain localized to the TMJ during function, and who were submitted to TMJ ALL and followed for a period of 12 months, with periodic reviews.

Results: ALL was effective in 93.6% of cases, with 85.3% experiencing improvement in mouth opening and 91.2% in pain reduction during function, 63% improvement in disk position and a rate of complications of 6.2%.

Conclusion: In this study the ALL exhibited a high rate of success with low morbidity in internal derangements of the TMJ.

© 2015 Associação Brasileira de Otorrinolaringologia e Cirurgia Cérvico-Facial. Published by Elsevier Editora Ltda. All rights reserved.

[☆] Please cite this article as: da Silva PA, Lopes MTFF, Freire FS. A prospective study of 138 arthroscopies of the temporomandibular joint. Braz J Otorhinolaryngol. 2015;81:352–7.

^{☆☆} Institution: IECS Instituto Educacional de Ciências da Saúde, Sete Lagoas, MG, Brazil.

* Corresponding author.

E-mail: drpauloalexandre@terra.com.br (P.A. da Silva).

PALAVRAS-CHAVE

Artroscopia;
Articulação
temporomandibular;
Transtornos da
articulação
temporomandibular;
Disco da articulação
temporomandibular;
Síndrome da
disfunção da
articulação
temporomandibular

Estudo prospectivo de 138 artroscopias da articulação temporomandibular**Resumo**

Introdução: Os desarranjos internos (DI) da articulação temporomandibular (ATM), possuem etiologia multifatorial, sendo tratados na maioria das vezes de forma conservadora através *splints*, fisioterapia e medicamentos. Apenas 2% a 5% dos casos tem indicação cirúrgica, seja através de artroscopia ou artrotomia.

Objetivo: Avaliar melhora da abertura bucal, melhora da dor, posicionamento do disco articular e complicações pós Lise e Lavagem Artroscópica (ALL).

Método: Estudo prospectivo com uma série de 78 pacientes (138 ATMs) com DI da ATM, sendo 5 homens e 73 mulheres, com média etária de 29,7 anos, atendidos entre janeiro de 2010 e abril de 2013, refratários ao tratamento conservador, apresentando limitação de abertura bucal e dor localizada em ATM em função, sendo submetidos à ALL da ATM e acompanhados por um período de 12 meses, com avaliações periódicas.

Resultados: A ALL foi eficiente em 93,6% dos casos estudados, com 85,3% melhora na abertura bucal e 91,2% na redução da dor em função, 63% de melhora na posição discal em RM de controle e índice 6,2% de complicações.

Conclusão: No presente estudo a ALL mostrou-se um tratamento com um alto índice de sucesso, com baixa morbidade, nos desarranjos internos da ATM.

© 2015 Associação Brasileira de Otorrinolaringologia e Cirurgia Cérvico-Facial. Publicado por Elsevier Editora Ltda. Todos os direitos reservados.

Introduction

Internal disorders (ID) of the temporomandibular joint (TMJ) have a multifactorial etiology, and their treatment constitutes a significant challenge for clinicians and surgeons. For years, these disorders were treated conservatively, mostly by the use of splints and anti-inflammatory agents. Surgical treatment is indicated in only 2–5% of cases, and in most cases it is performed by arthrotomy. In 1975, Ohnishi¹ was the first surgeon to use an arthroscope in TMJ, when this author studied its movements and arthroscopic anatomy. In the 80s, several authors^{2–5} contributed to the development of TMJ arthroscopy, with descriptions of various techniques and an understanding of the internal changes viewed arthroscopically. From the end of the 80s to now, there has been great progress in arthroscopy, mainly due to a better quality of magnetic resonance imaging (MRI) studies and also to an understanding of the pathophysiology of ID. Bronstein and Merrill⁶ correlated the stages of Wilkes⁷ with their arthroscopic findings; Nitzan and Etsion⁸ reported on the interrelationship of the lubrication process and articular disk displacement; others developed and introduced several arthroscopic techniques, with excellent results, such as disk suture,^{9,10} co-ablation with radiofrequency,^{11,12} laser ablation,¹² drug injection,¹² disk fixation,¹³ and eminectomy.¹⁴

Arthroscopic Lyse and Lavage (ALL) was first described in the literature as “Lysis” by Sanders⁴ in 1986. In 1992, in a multicenter US study, results of 4861 TJM arthroscopic procedures were collected, and among all techniques performed, 85% were ALL. Thus, ALL was noted to be the most frequently performed procedure in TMJ arthroscopy and was reported to have a global improvement index of 91.3%.¹⁵ With this technique, fibrosis and adhesions are disrupted by instrumentation through the working cannula, while

maintaining a continuous flow of 0.9% saline or Ringer’s solution. Thus, the product of the breakdown of adhesions and also its inflammatory components are eliminated, promoting a better anatomical and physiological condition and allowing better mobilization of TMJ and decreased pain.¹⁶ The aim of this study was to evaluate the success rate of the arthroscopic lysis and lavage (ALL) procedure in patients with TMJ internal disorders, in relation to improving the oral opening, decreasing pain symptoms, articular disk positioning in the post-procedural MRI, and complications of the technique.

Methods

This study was approved by the Institution’s Research and Ethics Committee (CEP), Protocol 121/2013. Seventy-eight patients (58 bilateral and 22 unilateral, totaling 138 ATMs) (Table 1), 5 males and 73 females, of 16–55 years (mean, 29.7 years), treated between January 2010 and April 2013, were included in this prospective study. All participants met the inclusion criteria: limitation of mouth opening and/or localized pain in function which was refractory to conservative treatment with myorelaxant splint, physical therapy and medications. The diagnosis of TMJ internal disorder (ID) was performed by clinical examination, with mouth opening measurement with the use of a specific millimeter ruler – Therabite scale (Great Lakes Orthodontics, Tonawanda, NY, USA); Visual Analog Scale (VAS) for auto-informed subjective pain assessment, with scores ranging from 0 to 10 (0 = no pain, 10 = severe pain); Joint Load Test consisting of interposition of two wooden spatulas between the posterior teeth contralateral to the TMJ under consideration; in case of pain, the test reveals some degree of inflammation; and by magnetic resonance imaging (MRI). Comorbidities were investigated with the help of laboratory tests, taking into

Table 1 Relationship between patients and affected TMJs.

Patients	Unilateral	Bilateral	Total of TMJs
78	24	58	138

Table 2 Relationship between TMJs and Wilkes stage.

TMJs	Wilkes II	Wilkes III	Wilkes IV	Wilkes V
138	42	57	31	8

account information obtained from history, to rule out possible involvement of systemic factors, such as rheumatoid arthritis and female hormonal dysfunction, among others. At the initial clinical examination, patients had an average of 21.2 mm of mouth opening and/or localized pain in function (mean VAS of 6.75, and positive for a joint load test). Among 138 ATMs studied, 42 were in Wilkes stage II, 57 in Wilkes III, 31 in Wilkes IV, and 8 in Wilkes V (Table 2). All patients underwent general anesthesia with nasal intubation. In all cases, patients received antibiotic prophylaxis with cephalothin 2 g at induction of anesthesia. In all procedures, 1.9 mm, zero-degree optical device, sleeves, sharp and blunt perforators, adhesion knives, an exploratory probe, and a bipolar electrode (Karl Storz Endoscopy, Tuttlingen, Germany) (Fig. 1) were used. ALL was performed with a puncture, sweep and triangulation technique described by McCain et al.¹⁷ under irrigation with Ringer's. Instrumentation was performed for removal of adhesions, synovitis cauterization and mobilization of the articular disk (Figs. 2–5). At the end of the procedure, sodium hyaluronate infiltration, 20 mg (TBR Polireumin® Pharma, São Paulo, SP, Brazil), was performed. All arthroscopic procedures were performed by the same professional. Patients were discharged after 12–24 h, and naproxen sodium 500 mg 12/12 h for 3 days was prescribed. Patients were instructed to maintain a soft diet for 30 days, use a Michigan myorelaxant plate, limit mouth opening, and perform laterality and mandibular protrusion passive exercises during the first 15 days, and return to physical

**Figure 1** Optics and instruments used in ALL.**Figure 2** ALL being performed with the optical device in position, reflux needle and triangulation for instrumentation.

therapy after this period. Physical therapy and plate use were maintained for 6 months postoperatively. All patients were evaluated postoperatively at 24 h, 72 h, 7 days, 15 days, 21 days and 30 days, and then monthly. During follow-up, pain improvement in function (VAS and load testing) and improved mouth opening amplitude were evaluated. All complications arising from ALL were also evaluated, with the exception of: pain at the puncture site; discrete posterior open bite, and transient limitation of mouth opening (such events are expected in the early days, being inherent

**Figure 3** Instrumentation with angled probe to remove anterior recess adhesions.

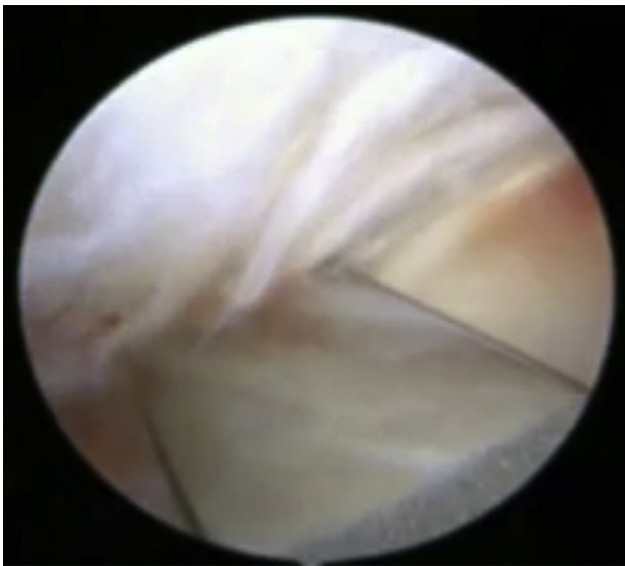


Figure 4 Instrumentation with knife, with removal of adhesions in the intermediate zone (between eminence and articular disk).

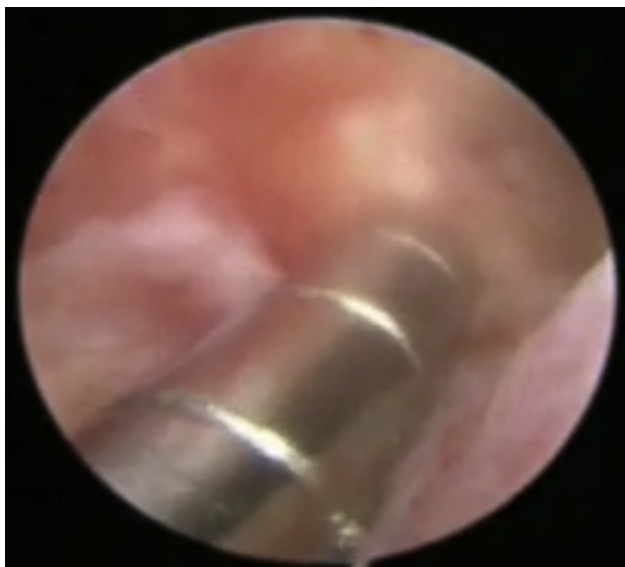


Figure 5 Straight probe into posterior recess of TMJ mobilizing the disk to its anatomical position, after adhesion removal.

to the procedure). A control magnetic resonance imaging (MRI) study after 6 months was obtained for disk positioning assessment in relation to the initial MRI. At 6 months, in the case of persistence or worsening of the clinical picture, arthrotomy was indicated. The total follow-up of patients was 12 months.

Results

Of 78 enrolled patients, after 6 months of follow-up, 5 (6.4%) did not obtain a favorable result, due to persistent limitation of mouth opening. This represented 9 ATMs (3 Wilkes V and 6 Wilkes IV), i.e., 6.52% for all 138 joints studied. In these cases, discopexy with use of mini-anchors was

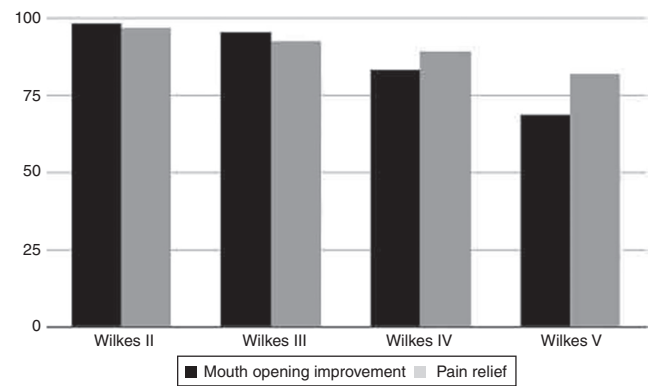


Figure 6 Relationship between means (in percentage) of mouth opening improvement and pain relief, compared to Wilkes stages found during TMJ arthroscopy.

performed, obtaining the resolution of the clinical picture, with significant improvement in mouth opening. The success rate of ALL was 93.59% considering all 78 patients enrolled; and 93.48% when considering all 138 ATMs treated. In the item “mouth opening improvement” and considering all 78 patients, the overall index was 85.3%, with variations in the means obtained: 68.7% for Wilkes V patients; 83.2% for Wilkes IV; 92.5% for Wilkes III, and 96.8% for Wilkes II. The smallest and the largest lengths were 36 mm and 52 mm, respectively, with a global mean of 45 mm. Still considering the 78 patients studied, “improvement of pain in function” occurred in 91.2%, with variations in the means obtained: 81.9% for Wilkes V patients; 89.2% for Wilkes IV; 95.4% for Wilkes III, and 98.3% for Wilkes II. The lowest and highest VAS scores were 6 and 10, respectively, with a global mean of 9.2 (Fig. 6). After six months, control MRIs showed that in 63% of cases, there was improvement in articular disk position, with its location between 11 and 12h (at rest), compared with initial MRIs, where the discs were displaced. Eleven cases (7.9%) of post-ALL complications in our 138 ATMs occurred, as follows: 5 cases of fluid accumulation in the site (3.6%), 3 cases of hearing fullness and/or loss (2.2%), 2 cases of ear canal lacerations (1.4%), and 1 case of paralysis of the temporal branch of facial nerve (0.7%) (Table 3). All complications were transient, not requiring additional treatment.

Discussion

Arthroscopic lysis and lavage has been successfully employed in internal disorders (ID) of TMJ refractory to conservative therapy with occlusal splints and physiotherapy. In this study, all patients were previously treated with splints and physiotherapy, and were referred for the procedure because there was persistence of limited mouth opening and/or intra-articular pain.

In the literature, the success rate for improving oral opening and pain symptoms vary. Sanders and Buoncristiani¹⁸ described their clinical experience using ALL and obtained excellent results in 82% of their patients with a maximum inter-incisal opening (MIO) of not less than 40 mm, and little or no TMJ pain. Indresano¹⁹ obtained a 73% success rate in a series of 64 patients undergoing arthroscopy. Moses et al.²⁰

Table 3 Post-ALL complications.

TMJs	Local fluid accumulation	Hearing fullness	Ear canal laceration	Paralysis of the temporal branch of facial nerve	Total
138	3.6%	2.2%	1.4%	0.7%	11 (7.9%)

recommended movements with cannula and blunt trocar in the anterior-posterior direction, and obtained a reduction of pain in 92% of 237 patients undergoing ALL; these authors also reported improvement in mouth opening to greater than 40 mm with MIO in 78%. Perrot et al.²¹ observed decreased pain and increased joint mobility in a prospective study of 76 joints treated with ALL; the whole group was treated with corticosteroid injection. Clark et al.²² observed a reduction of pain in 57% of patients and improvement in the range of mandibular movement in 83%. In a follow-up study of 63 patients over 4 years, Moore²³ concluded that ALL was beneficial in 87% of patients. Kurita et al.²⁴ reported an overall response rate of 86% when using ALL for treating TMJ internal disorders. In patients undergoing ALL, Dimitroulis²⁵ reported good results in 66%, slight improvement in 18%, and no improvement in 16%. Gonzalez Garcia et al.²⁶ showed that ALL was as effective as surgical arthroscopy with respect to postoperative pain reduction or mouth opening increase at any stage of the follow-up period. Kondoh et al.²⁷ reported a 80% success rate with the use of ALL for TMJ internal disorder. Sorel and Picuch²⁸ reported a long-term beneficial effect of ALL for the treatment of chronic TMJ pain, noting that 95% of their patients who were followed for 4.4 years had no significant complaints and had a significant increase in mouth opening. Some authors observed that the success rate of ALL depends on the Wilkes stage for the TMJ. Bronstein and Merrill⁶ observed 96% of success for stage II, 83% for stage III, 88% for stage IV, and 63% for stage V. Smolka and Iizuka²⁹ observed a average success rate of 86.7%, ranging from 75% to 92.3% according to the stage into which the TMJ was. These variations in results were also observed in the present study, with variations according to the Wilkes stage, but global means that were consistent with the studies reviewed during the study period. In the present study, we did not recommend repeated arthroscopy for patients whose ALL failed by the clinical criteria, because of the large displacement and more advanced process of degeneration of the discs (Wilkes IV and V). Instead, we opted for an arthrotomy and discopexy with mini-anchors, although we agree that, in some cases, one should consider undertaking a repeat arthroscopy before this arthrotomy, as suggested in the study by Abd-El-Salam et al.³⁰ In our study, we observed in the control RMs a new disk positioning, closer to its anatomical position. This new articular disk position after the ALL procedure was also observed by Clark et al.³¹; Moses and Topper³² believe that this new articular disk position is not related to its repositioning, but secondary to disk mobilization and to the removal of adhesions and inflammatory degenerative products.

With respect to complications, Tsuyama et al.³³ experienced 10.3% in 301 cases of ALL; 8.6% of these cases were otologic complications and 1.7% were lesions of the trigeminal and facial cranial nerves. These authors concluded that a high level of understanding of the regional anatomy will

help in reducing complications associated with the completion of ALL. Based on 10 years of clinical experience, Carls et al.³⁴ reported a complication rate of 1.77% in 451 TMJ arthroscopies in 373 patients. These complications were transient and mainly related to V and VII cranial nerves. In a study of 2034 patients, Zhang et al.³⁵ observed a low rate of complications, namely: 5 bleedings, 5 neuropraxias, 3 instrument breakage, 2 foreign body reactions and 2 tympanic membrane perforations. Gonzalez-Garcia et al.³⁶ observed 1.34% of complications, as follows: ear canal laceration, auriculotemporal nerve paresthesias, facial nerve paralysis and impaired visual acuity – all of them being transient complications. Several other complications have been reported in the literature, such as infections,³⁷ arteriovenous fistulas,³⁸ pseudoaneurysms,³⁹ bradycardias^{40,41} and asystoles,⁴² all being very rare. In this study, our rate of complications was situated within the range observed in the literature, and all occurrences were transient, not requiring additional treatment.

Conclusion

Lysis and arthroscopic lavage (ALL) is a minimally invasive treatment, with efficient results in patients with TMJ internal disorders refractory to conservative therapy. ALL results in a significant improvement in the range of mouth opening, decreases pain in function and improves articular disk position. In addition, this procedure carries a low complication rate. Therefore, ALL is a safe procedure in the hands of surgeons who have mastered the technique. Further studies are needed, including a long-term follow-up, to consolidate the results.

Conflicts of interest

The authors declare no conflicts of interest.

References

- Ohnishi M. Arthroscopy of the temporomandibular joint. *J Jpn Stomatol.* 1975;42:203–7.
- Murakami K, Ito I. Arthroscopy of the temporomandibular joint. Arthroscopic anatomy and arthroscopic approaches in the human cadaver. *Arthroscopy.* 1981;6:1–13.
- Murakami K, Hoshino K. Regional anatomic nomenclature and arthroscopic terminology in the human temporomandibular joints. *Okamimas Folia Anat Jpn.* 1982;58:745–60.
- Sanders B. Arthroscopic surgery of the temporomandibular joint: treatment of internal derangement with persistent closed lock. *Oral Surg Oral Med Oral Pathol.* 1986;62:361–72.
- McCain JP. Arthroscopy of the human temporomandibular joint. *J Oral Maxillofac Surg.* 1988;46:645–55.

6. Bronstein SL, Merrill RG. Clinical staging for TMJ internal derangement: application to arthroscopy. *J Craniomandib Disord.* 1992;6:7.
7. Wilkes CH. Internal derangements of the temporomandibular joint. Pathological variations. *Arch Otolaryngol Head Neck Surg.* 1989;115:469–77.
8. Nitzan DW, Etsion I. Adhesive force: the underlying cause of the disc anchorage to the fossa and/or eminence in the temporomandibular joint – a new concept. *Int J Oral Maxillofac Surg.* 2002;31:94–9.
9. McCain JP, Podrasky AE, Zabiegalski NA. Arthroscopic disc repositioning and suturing: a preliminary report. *J Oral Maxillofac Surg.* 1992;50:568–79.
10. Yang C, Cai XY, Chen MJ, Zhang SY. New arthroscopic disc repositioning and suturing technique for treating an anteriorly displaced disc of the temporomandibular joint: Part I – Technique introduction. *Int J Oral Maxillofac Surg.* 2012;41:1058–63.
11. Chen MJ, Yang C, Zhang SY, Cai XY. Use of coblation in arthroscopic surgery of the temporomandibular joint. *J Oral Maxillofac Surg.* 2010;68:2085–91.
12. McCain JP, Hossameldin RH. Advanced arthroscopy of the temporomandibular joint. *Atlas Oral Maxillofac Surg Clin North Am.* 2011;19:145–67.
13. Goizueta-Adame CC, Pastor-Zuazaga D, Orts Bañón JE. Arthroscopic disc fixation to the condylar head. Use of resorbable pins for internal derangement of the temporomandibular joint (stage II–IV). Preliminary report of 34 joints. *J Craniomaxillofac Surg.* 2013. <http://dx.doi.org/10.1016/j.jcms.2013.05.023>.
14. Undt G. Temporomandibular joint eminectomy for recurrent dislocation. *Atlas Oral Maxillofac Surg Clin North Am.* 2011;19:189–206.
15. McCain JP, Sanders B, Koslin M. Temporomandibular joint arthroscopy: a 6 years multicenter retrospective study of 4.831 joints. *J Oral Maxillofac Surg.* 1992;50:926.
16. González-García R, Gil-Díez Usandizaga JL, Rodríguez-Campo FJ. Anatomy and lysis and lavage of the temporomandibular joint. *Atlas Oral Maxillofac Surg Clin North Am.* 2011;19:131–44.
17. McCain JP, de la Rua H, LeBlanc WG. Puncture technique and portals of entry for diagnostic and operative arthroscopy of the temporomandibular joint. *Arthroscopy.* 1991;7:221–32.
18. Sanders B, Buoncristiani R. Diagnostic and surgical arthroscopy of the temporomandibular joint: clinical experience with 137 procedures over a 2-year period. *J Craniomandib Disord.* 1987;1:202–13.
19. Indresano AT. Arthroscopic surgery of the temporomandibular joint: report of 64 patients with long-term follow-up. *J Oral Maxillofac Surg.* 1989;47:439–41.
20. Moses JJ, Sartoris D, Glass R, Tanaka T, Poker I. The effects of arthroscopic lysis and lavage of the superior joint space on TMJ disc position and mobility. *J Oral Maxillofac Surg.* 1989;47:674–8.
21. Perrot DH, Alborzi A, Kaban LB. A prospective evaluation of the effectiveness of temporomandibular joint arthroscopy. *J Oral Maxillofac Surg.* 1990;48:1029–32.
22. Clark GT, Sanders B, Bertolami CH. Advances in diagnostic and surgical arthroscopy of the temporomandibular joint. Philadelphia: WB Saunders; 1993.
23. Moore LJ. Arthroscopic surgery for the treatment of restrictive temporomandibular joint disease. A prospective longitudinal study. In: Clark G, Sanders B, Bertolami C, editors. *Advances in diagnostic and surgical arthroscopy of the temporomandibular joint.* Philadelphia: WB Saunders; 1993. p. 35–40.
24. Kurita K, Goss AN, Ogi N. Correlation between preoperative mouth opening and surgical outcome after arthroscopic lysis and lavage in patients with disc displacement without reduction. *J Oral Maxillofac Surg.* 1998;56:1394–7.
25. Dimitroulis G. A review of 56 cases of chronic closed lock treated with temporomandibular joint arthroscopy. *J Oral Maxillofac Surg.* 2002;60:519–24.
26. González-García R, Rodríguez-Campo FJ. Arthroscopic lysis and lavage versus operative arthroscopy in the outcome of temporomandibular joint internal derangement: a comparative study based on Wilkes stages. *J Oral Maxillofac Surg.* 2011;69:2513–24.
27. Kondoh T, Dolwick MF, Hamada Y, Seto K. Visually guided irrigation for patients with symptomatic internal derangement of the temporomandibular joint: a preliminary report. *Oral Surg Oral Med Oral Pathol Oral Radiol Endodontol.* 2003;95:544–51.
28. Sorel B, Picuch JF. Long-term evaluation following temporomandibular joint arthroscopy with lysis and lavage. *Int J Oral Maxillofac Surg.* 2000;29:259–63.
29. Smolka W, Iizuka T. Arthroscopic lysis and lavage in different stages of internal derangement of the temporomandibular joint: correlation of preoperative staging to arthroscopic findings and treatment outcome. *J Oral Maxillofac Surg.* 2005;63:471–8.
30. Abd-Ul-Salam H, Weinberg S, Kryshtalskyj B. The incidence of reoperation after temporomandibular joint arthroscopy surgery: a retrospective study of 450 consecutive joints. *Oral Surg Oral Med Oral Pathol Oral Radiol Endodontol.* 2002;93:408.
31. Clark GT, Sanders B, Bertolami CH. *Advances in diagnostic and surgical arthroscopy of the temporomandibular joint.* Philadelphia: WB Saunders; 1993.
32. Moses JJ, Topper DC. A functional approach to the treatment of temporomandibular joint internal derangement. *J Craniomandib Disord.* 1991;5:19–27.
33. Tsuyama M, Kondoh T, Seto K, Fukuda J. Complications of temporomandibular joint arthroscopy: a retrospective analysis of 301 lysis and lavage procedures performed using the triangulation technique. *J Oral Maxillofac Surg.* 2000;58:500–5.
34. Carls FR, Engelke W, Locher MC, Sailer HF. Complications following arthroscopy of the temporomandibular joint: analysis covering a 10-year period (451 arthroscopies). *J Craniomaxillofac Surg.* 1996;24:12–5.
35. Zhang S, Yang C, Cai X, Liu X, Huang D, Xie Q, et al. Prevention and treatment for the rare complications of arthroscopic surgery in the temporomandibular joint. *J Oral Maxillofac Surg.* 2011;69:347–53.
36. González-García R, Rodríguez-Campo FJ, Escorial-Hernández V, Muñoz-Guerra MF, Sastre-Pérez J, Naval-Gías L, et al. Complications of temporomandibular joint arthroscopy: a retrospective analytic study of 670 arthroscopic procedures. *J Oral Maxillofac Surg.* 2006;64:1587–91.
37. McCain JP, Zabiegalski NA, Levine RL. Joint infection as a complication of temporomandibular joint arthroscopy: a case report. *J Oral Maxillofac Surg.* 1993;51:1389–92.
38. Moses JJ, Topper DC. Arteriovenous fistula: an unusual complication associated with arthroscopic temporomandibular joint surgery. *J Oral Maxillofac Surg.* 1990;48:1220–2.
39. Kornbrot A, Shaw AS, Toohey MR. Pseudoaneurysm as a complication of arthroscopy: a case report. *J Oral Maxillofac Surg.* 1991;49:1226–8.
40. Roberts RS, Best JA, Shapiro RD. Trigemino-cardiac reflex during temporomandibular joint arthroscopy: report of a case. *J Oral Maxillofac Surg.* 1999;57:854–6.
41. Gomes TM, Van Gilder JW. Reflex bradycardia during TMJ arthroscopy: case report. *J Oral Maxillofac Surg.* 1991;49:543–4.
42. Momota Y, Kotani J, Ueda Y, Kakudo K. Cardiac asystole during arthroscopic surgery of the temporomandibular joint: a case report. *J Oral Maxillofac Surg.* 1999;57:189–91.