



Changes in the orofacial myofunctional system after treatment for facial trauma: a critical review of the literature

Sistema miofuncional orofacial e trauma de face: revisão crítica da literatura

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■ ABSTRACT

Introduction: This qualitative literature review aims to highlight international scientific publications selected from the PubMed database that describe the changes in the function of the orofacial myofunctional system after facial trauma and the associated treatment outcomes. **Methods:** Studies published in English between 2005 and 2011 and including individuals of all age groups were included in this review. Publications that were not open access, studies appearing more than once because of overlapping keywords, case studies, literature reviews, letters to the editor, and studies that were not directly related to the subject were excluded. **Results:** A total of 831 studies were identified, 14 of which fulfilled the established criteria. Assessment of jaw function was the most frequent evaluation performed in the included studies, followed by the analysis of treatments. The incidence of condylar fractures was higher than that of mandibular angle fractures. The majority of cases were managed by surgery combined with conservative treatment, followed by surgery alone and conservative treatment alone. Adult men exhibited a higher incidence of facial trauma. Few studies included children or control groups. Further assessment of jaw and clinical functions before and after surgery revealed the following findings. The bite force and occlusal contact area improved after treatment, whereas mandibular asymmetry persisted even after surgery. The maximum mouth opening returned to normal after treatment, although the range of mouth opening was lower in patients with facial trauma than in controls. Persistent mobility in the mandibular teeth and pain were observed even after treatment. Myofunctional therapy resulted in an overall improvement in jaw function. **Conclusions:** Although the number of studies on facial trauma is increasing, few studies address the use and benefits of orofacial myofunctional therapy in this field. Further studies on orofacial myofunctional therapy combined with surgery and/or conservative treatment for facial trauma are necessary.

Keywords: Facial trauma; Myofunctional Therapy; Rehabilitation; Speech Therapy; Stomatognathic System.

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RESUMO

Introdução: Esta revisão qualitativa da literatura levantou publicações científicas internacionais sobre a funcionalidade do sistema miofuncional orofacial nos traumas faciais, por meio da base de dados PubMed. **Método:** O levantamento realizado limitou-se a seres humanos, de qualquer faixa etária, no idioma inglês, entre os anos de 2005 e 2011. As publicações sem acesso completo, repetidas por sobreposição das palavras chave, estudos de caso, revisões de literatura, cartas ao editor e as não relacionadas diretamente ao tema foram excluídas. **Resultados:** Foram identificados 831 estudos, sendo 14 dentro dos critérios estabelecidos. Notou-se que a avaliação mais frequente foi a da função mandibular e depois análise de tratamentos; ocorreu mais fratura no côndilo que ângulo mandibular; utilizou-se mais tratamento cirúrgico juntamente com o conservador, seguido pelo somente cirúrgico e finalmente somente conservador; a maior incidência de traumas faciais foi em adultos do sexo masculino; poucas pesquisas foram realizadas com crianças e grupo-controle; utilizaram-se mais avaliações da função mandibular e clínicas, na maioria pré e pós-cirurgia; a força de mordida e a área oclusal apresentaram melhora pós-tratamento, no entanto a assimetria mandibular permaneceu; os valores de abertura máxima da boca atingiram a normalidade, porém inferiores ao grupo-controle; houve persistência de alterações na mobilidade mandibular e dor, mesmo após o tratamento; e a terapia miofuncional melhorou o quadro de alterações. **Conclusão:** É necessário mais publicações sobre o tratamento fonoaudiológico baseado na abordagem miofuncional orofacial nos traumas faciais.

Descritores: Lesões Faciais; Terapia Miofuncional; Reabilitação; Fonoaudiologia; Sistema Estomatognático

INTRODUCTION

Facial trauma involves injuries to the facial soft tissues and bones, and, in cases of extensive trauma, the brain, eyes, sinuses, and teeth. The epidemiology of this form of trauma is diverse and varies with type, severity, and cause of the injury¹.

The primary cause of maxillofacial fractures is road accidents^{2,3}. However, increased interpersonal violence¹ and the use of firearm bullets also lead to an increased incidence of facial trauma.

The effects of facial trauma may be reversible or irreversible and may lead to emotional, functional, and esthetic impairments. The incidence of facial fractures is higher in men than in women. However, over the past few decades, the incidence has increased in women aged below 40 years⁵⁻⁷, with a lower incidence in children and individuals older than 40 years^{8,9}.

Changes in the organs of articulation after facial trauma are a topic of great interest in the field of speech and language therapy. Such changes interfere with stomatognathic functions such as breathing, speaking, chewing, and swallowing. Speech therapy based on the changes in the function of the orofacial myofunctional system after facial trauma is an important complementary treatment because it helps in restoring normal oral functions and decreases the risk of hypomobility and prevents the progression of possible sequelae¹⁰⁻¹⁵.

In the abovementioned context, this literature review was performed to analyze scientific publications describing changes in the function of the orofacial myofunctional system after facial trauma, specifically in the maxilla and mandible, and the associated treatment outcomes.

METHODS

This qualitative literature review included articles selected from the PubMed database using the following keywords: "facial injuries and oral muscle," "facial injuries and oral structure," "facial injuries and speech," "facial injuries and voice," "facial injuries and chewing," "facial injuries and mastication," "facial injuries and deglutition," "facial injuries and swallowing," "facial injuries and breathing," "facial injuries and myofunctional system," and "facial injuries and oral function." All studies published in English between 2005 and 2011 and including all age groups were included.

To establish the principles of the research method employed, the precepts of the Cochrane Handbook¹⁶ were followed with regard to formulation of the question, location, study selection, and critical evaluation.

For appropriate study selection, it was first necessary to achieve compatibility among the researchers. The articles were independently searched in the database by the authors, with the aim to minimize possible citation loss. Studies published in languages other than English were excluded. Studies without full text access (obtained from the CAPES Journal Portal); those appearing multiple times because of overlapping keywords; full articles submitted as case studies, literature reviews, or letters to the editor; and studies that were not directly related to the subject (studies related to surgical technique, fractures in regions of the face other than the maxilla and/or mandible, or changes in sensitivity and animal studies) were also excluded. All phases of the study were independently conducted by the researchers. In case of disagreement, stud-

ies were included on the basis of a final consensus. This study was not a simple blind search.

The study selection flowchart is illustrated in Figure 1.

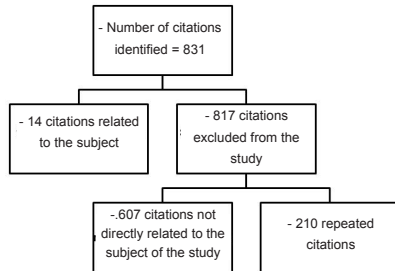


Figure 1. Study selection flowchart

After the bibliographic survey and study selection, the manuscripts were analyzed with regard to the aims, number, and gender of the participants, age groups, evaluated parameters, treatment controls, and results. This analysis is described in subsequent session.

RESULTS

The results of the literature search used in this study are briefly described in Table 1.

DISCUSSION

The findings of this literature review indicated that most of the studies aimed at the evaluation of mandibular function^{17,18,21,24,25,27,28-30} and the analysis of treatment outcomes^{19,22,23,26} and facial trauma-related complaints (poor or

Table 1. Summary of the evaluated studies

Reference	Aim	Sample	Evaluated parameters and treatment controls	Results and Conclusions
Gerlach and Schawarz, 2012 ¹⁷	To assess the maximum bite force in patients with mandibular angle fractures that were surgically treated	Twenty men and two women with mandibular angle fractures aged 27 to 38 years Age and gender-matched controls	Electrical method used to measure the bite force (transducer positioned in the region of the incisors, canines, and molars) Longitudinal monitoring of patients (once a week for 6 weeks)	The bite force of the patients significantly decreased in the first week after surgery compared with that in the control group and became equivalent to that in the control group after 6 weeks.
Murakami et al., 2009 ¹⁸	To analyze the mandibular movement and the occlusal condition of patients who underwent conservative treatment for unilateral condylar fractures	Fourteen men and four women were divided in two groups: 1) Twelve underwent maxillomandibular fixation + physical therapy 2) Six underwent physical therapy alone Average age, 38 years Control group	The participants were evaluated 3 and 6 months after treatment initiation. Evaluated parameters: mandibular movement	After 6 months, the maximum mouth opening was normal in the patient groups, although the range was lower than that in the control group. Recovery of lateralization and protrusion movements was observed. Mandibular deviation was observed on mouth opening, although the values were lower than those before treatment. After 6 months of treatment, a decrease in the bite force and level of asymmetry in the occlusal contact area was observed.
Kondoh et al., 2004 ¹⁹	To compare closed reduction + intermaxillary fixation + intra-articular irrigation (corticosteroid) and closed reduction + intermaxillary fixation without intra-articular irrigation for unilateral condylar fractures	Twenty-six patients with unilateral condylar fracture were divided in two groups: 1) Fourteen underwent conservative treatment + intra-articular irrigation 2) Twelve underwent conservative treatment only Average age, 25 years	Evaluated parameters: radiological findings, jaw function, and pain in the TMJ	Three months after injury, the maximum mouth opening was significantly greater in the intra-articular irrigation group. TMJ pain gradually decreased over the course of treatment in the irrigation group, while in the other group, pain decreased only 6 months after treatment. The conservative treatment protocol modified with intra-articular irrigation was found to be minimally invasive and safe for the treatment of unilateral condylar fractures.

Niezen et al., 2010 ²⁰	To analyze the relationship between impaired jaw function after closed treatment of mandibular condylar fractures.	Seventy-three men and 41 women Average age, 28 years	Physical examination: articular sounds; pain during mandibular movement; measurements of maximum mouth opening, lateralization, and protrusion; and evaluation of the dentition and occlusion Questionnaire: impairment of mandible function	Pain, abnormal occlusion, decreased mouth opening, abnormal values of lateralization, and advanced age were found to be predictors of jaw function impairment in patients who undergo closed treatment of mandibular condylar fractures.
Thorén et al., 2001 ²¹	To investigate the incidence of functional impairment and radiological findings related to the TMJ in children with condylar fractures that were not surgically treated	A total of 138 children with uni- or bilateral condylar fractures	Questionnaire on TMJ function Radiological examination Clinical examination: palpation and TMJ auscultation; investigation and measurement of midline deviations during mouth opening; and measurement of the maximum mouth opening, lateralization, and protrusion Monitoring period: from 4.8 to 16.4 years	Totally, 56% patients exhibited some form of symptoms and 72% showed signs of objective TMJ dysfunction. It was found that conservative treatment may be indicated for patients below 15 years old.
Hlawitschka et al., 2005 ²²	To evaluate and compare the results of open and closed treatments for intracapsular fractures	Forty-three patients were divided into two groups: 1) Fourteen (15 fractures) with an average age of 31 years were treated by open reduction with internal fixation 2) Twenty-nine (34 fractures) with an average age of 28 years were treated by closed reduction	Clinical examination Radiological examination Axiography	Patients treated by internal fixation showed better radiological outcomes Both groups showed signs of persistent dysfunction, although lesser impairment was observed in the group treated with internal fixation Axiography revealed significant limitations in condylar movements in both groups, although TMJ irregularities were significantly less frequent in the open treatment group. It was found that in cases of complex reconstruction of the mandibular condyle, open reduction and internal fixation improve the prognosis of bone anatomy and recovery of soft tissues when combined with therapeutic exercises after surgery.
Kaplan et al., 2001 ²³	To compare the results of open reduction and internal fixation between patients with displaced mandibular fractures who underwent immediate mobilization and those who did not.	Twenty-nine patients older than 16 years who underwent open reduction and internal fixation were divided into two groups: 1) Sixteen underwent immediate mobilization 2) Thirteen underwent maxillomandibular fixation for 2 weeks	Evaluation time points: six weeks and 3 and 6 months after surgery. Evaluated parameters: pain, fracture healing, occlusal condition, trismus, inferior alveolar nerve condition, weight loss, and wound infection Evaluated by a blinded surgeon	There was no significant difference between groups in any of the evaluated parameters assessed at the different time points.
Rutges et al., 2006 ²⁴	To investigate the functional outcome of patients who undergo conservative treatment of condylar fractures	Twenty-eight patients (25 men and three women) with condylar fractures Average age: 30 years . Average time of fracture: 3 years.	Anamnesis Clinical examination: functionality was scored using the Helkimo index. Radiological examination	The clinical dysfunction index revealed serious symptoms in 11% patients, moderate symptoms in 39%, mild symptoms in 39%, and the absence of symptoms in 11%. In addition, there were severe alterations in occlusion in 21% patients, moderate alterations in 61%, and the absence of alterations in 11%. Anamnesis revealed the absence of symptoms in 89% patients. According to the established criteria, the conservative treatment of condylar fractures was satisfactory only in 46% patients.

Throckmorton et al., 2003 ²⁵	<p>To compare masticatory movements between patients with treated unilateral condylar fractures and healthy controls</p> <p>To establish the time required for the restoration of normal masticatory movements</p>	<p>Eighty-one men with condylar fractures aged 16 to 70 years</p> <p>Control group: Fifteen men aged 22 to 23 years</p>	<p>Recording of mandibular movements and computational analysis of chewing</p> <p>Evaluation time: six weeks, 6 months and 1 and 2 years after treatment</p> <p>Treatments: open or closed reduction + physical therapy (elastics and guided jaw mobilization)</p>	<p>The total duration of chewing cycles and the phases of mouth opening and jaw closing were significantly lesser in the control group than in the treated patients, regardless of the chewing side, type of treatment, and evaluation time</p> <p>It was found that unilateral condylar fractures can alter the chewing cycle in adults for several years, particularly on the opposite side of the fracture.</p>
Gerbino et al., 2009 ²⁶	<p>To evaluate the efficacy and safety of a therapeutic method</p> <p>To analyze long-term clinical and radiological findings of patients who undergo open reduction and internal fixation of the condyle (extraoral approach)</p>	<p>Thirty-three men and 17 women with uni- or bilateral condylar fractures</p> <p>Average age: 30 years</p>	<p>Treatment: retromandibular access, preauricular + elastics for 7 days + elastics for more than 7 days only at night + intake of soft diet for 30 days + functional exercises from the 15th day + intensification of functional therapy after 30 days + persistence of training until 6 months after surgery</p> <p>Evaluation: radiological and clinical examinations</p> <p>Evaluation time points: before and after treatment.</p>	<p>A total of 12% patients exhibited facial muscle paralysis, which was permanent in 4%</p> <p>Clinical and radiological evaluation revealed satisfactory recovery of facial symmetry and excellent recovery of facial function. Few patients complained of symptoms related to TMJ. Condylar remodeling was extensive in 8% patients, mild or moderate in 47%, and absent in 45%. A statistically significant correlation was observed between condylar remodeling and impairment in mouth opening</p> <p>Surgical treatment associated with postoperative functional therapy was found to promote the recovery of occlusion, function, and facial symmetry.</p>
Sforza et al., 2009 ²⁷	<p>To quantitatively assess rotational and translational jaw movements during maximum mouth opening in patients who were successfully rehabilitated after condylar fractures</p>	<p>Eight men and one woman with condylar fractures</p> <p>Average age: 34 years</p> <p>Control group: healthy adult individuals matched to the patient group</p>	<p>All patients received functional therapy for approximately 40 days after surgery.</p> <p>Evaluated parameters: free mouth opening evaluated by three-dimensions analysis and division of movement into rotational and translational components and SEMS findings for the masseter, anterior temporal, and sternocleidomastoid muscles during maximum dental intercuspidation</p> <p>Moment: between the 6th and 36th month of treatment (average of 18 months)</p>	<p>Patients presented with a significantly lower range of mouth opening compared with controls, with a greater decrease in the vertical displacement component.</p> <p>Percentage of rotational movements was significantly higher in patients (82%) than in controls (77%).</p> <p>During maximum dental intercuspidation, patients showed higher asymmetry and significant higher torque and contraction values for the sternocleidomastoid muscle.</p> <p>Total recovery of opening movements could be achieved, although the rotational and translational components of this movement were altered.</p>

Throckmorton et al., 2004 ²⁸	To compare mandibular movements during chewing between patients with unilateral condylar fractures treated with open procedures and those treated with closed procedures	Eighty-one patients with unilateral condylar fractures treated with open (n = 37) or closed (n = 44) procedures Average age: 16 to 70 years	All patients were instructed to follow the same physical therapy protocol (elastics and exercises for mandibular movement). Evaluation: mandibular movements during mastication and computational analysis of the same Evaluation time: 6 weeks, 6 months, and 1 and 2 years after fracture Evaluated parameters: chewing cycle duration and maximum mandibular excursion during the chewing cycle, with three-dimensional analysis of the latter movement	There was no significant difference between groups in the duration of the chewing cycle and the maximum mandibular excursion. Surgical correction of unilateral condylar fractures was found to have little effect on mandibular movements the chewing pattern.
Jensen et al., 2006 ²⁹	To evaluate the long-term outcomes of open reduction and internal fixation for condylar fractures using the intraoral approach	Nine men and six women Average age: 42 years A total of 24 condylar fractures	Evaluation time points: before and after surgery (average of 23 months) Evaluation: clinical examination, radiological examination, assessment of the psychological status, measurement of maximum bite force in maximal occlusion, pain thresholds in TMJ and chewing muscles measured using a pressure algometer	Two patients were diagnosed with impaired TMJ movements Fracture healing was considered satisfactory in 12 joints Mini-plate fracture occurred in three patients and severe bone resorption of the condyle in one. Minor occlusal adjustments were necessary in six patients. No significant difference was found in the maximum bite force and maximum pain threshold between the fractured side and the normal side in patients with unilateral fractures and between the operated side and nonoperated side in patients with bilateral fractures. Open reduction and rigid internal fixation of condylar fractures using the intraoral approach requires expertise and was found to be associated with a high risk of postoperative complications.

Caldas et al., 2008 ³⁰	To monitor the growth of children with subcondylar fractures	Eighteen children Average age at trauma: 7.7 years A total of 21 fractures	Treatment: intermaxillary fixation for 12 to 17 days, liquid diet for 15 days after fixation, and functional treatment (mouth opening exercises) Follow-up: three to 6 years, with an average of 4.7 years Evaluation: palpation and auscultation of TMJs, evaluation of the interincisal distance, and measurement of the maximum lateral excursion of the jaw	The maximum interincisal distance during mouth opening varied from 34 to 43 mm (slight deviation to the side of fracture in four patients) The average lateralization to the side of fracture was 8.4 mm, while that to the contralateral side was 7.8 mm Conservative treatment of condylar fractures in growing individuals was found to result in satisfactory functional outcomes and condylar remodeling. Functional treatment after intermaxillary fixation for 12 to 17 days proved to be acceptable.
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TMJ, temporomandibular joint; SEMS, surface electromyography

moderate occluded area, decreased maximum mouth opening, asymmetric lateralization, mandibular deviation, and persistent pain)²⁰. Most studies included patients with condylar fractures^{18-21,29}, followed by mandibular angle¹⁷ and subcondylar fractures³⁰.

With regard to the treatment approach (surgical or conservative), five studies^{17,19,20,26,29} involved surgery, three^{18,21,24} involved conservative treatment, and six^{22,23,25,27,28,30} involved a combination of surgical and conservative treatments.

In general, these studies were performed in adults^{17-20,22-29}, with a higher incidence of facial trauma in men^{17,18,20,24-27,29,30}. Only two studies included children^{21,30}. Most studies did not use control groups^{19-23,26,28-30}. Studies with control groups allow for direct comparison of results and their application in the clinical setting and decrease potential biases that may lead to inaccurate interpretation of the results.

Most of the studies evaluated mandibular function^{19-21,23,28-30} and performed clinical examinations^{20-23,26,29,30}, followed by radiological^{19,21,22,26,29}, physical^{19,20}, psychological²⁹, and axiographic²² assessments. As in most of the surveys, the evaluation time points corresponded to the pre- and postoperative periods, with 6 weeks^{23,28} and 16.4 years²¹ as the minimum and maximum follow-up periods, respectively, after fracture.

For better discussion and characterization of the findings and conclusions related to orofacial myofunctional characteristics found in the articles that were fundamental for this study, specific aspects of greater relevance were addressed separately and were divided for didactic purposes into aspects related to the bite force and occlusal contact area, aspects related to static and dynamic occlusion and jaw mobility, and aspects related to pain.

With regard to the bite force and occlusal contact area, three studies showed that the bite force^{17,18,26} improved after treatment and over time, two showed an improved occlusal con-

tact area^{18,26}, and three^{18,21,27} reported the presence of asymmetry in these parameters after fracture correction.

With regard to dynamic occlusion, the maximum mouth opening returned to normal in some studies^{18,24,27,30}. However, some of these studies^{18,27,30} reported a lower range of mouth opening in patients than in controls. In one study²⁰, the maximum mouth opening was not restored to normal.

With regard to jaw mobility, one study¹⁸ observed a limited recovery in jaw mobility. In four studies^{20-22,30}, alterations in jaw mobility persisted in the long term.

The persistence of pain despite treatment was reported in several studies^{20,22,29}, and only one study¹⁹ reported a decrease in pain.

In several studies^{22,25,27,28,30}, jaw function improved when facial fractures were treated in combination with orofacial myofunctional therapy, and even after surgical and/or conservative treatment, changes in asymmetry and jaw mobility were still observed. The combination of a myofunctional approach with surgery and/or conservative treatment for jaw fractures can improve the overall jaw function.

CONCLUSIONS

Although the number of studies on facial trauma is increasing, few studies address the use and benefits of orofacial myofunctional therapy in this field. Although an increasing number of studies in international databases are emphasizing on the use of orofacial myofunctional therapy in combination with surgery and/or conservative treatment for facial trauma, these are inadequate and provide little scientific evidence. More specific studies are required to demonstrate the benefits of this therapy and define the methodologies that should be applied by skilled professionals.

REFERENCES

1. Carvalho TB, Candian LR, Marques CG, Piatto VB, Maniglia JV, Molina FD. Six years of facial trauma care: an epidemiological analysis of 355 cases. *Braz J Otorhinolaryngol.* 2010;76(5):565-74.
2. Chandra Shekar BR, Reddy C. A five-year retrospective statistical analysis of maxillofacial injuries in patients admitted and treated at two hospitals of Mysore city. *Indian J Dent Res.* 2008;19(4):304-8.
3. Hussaini HM, Rahman NA, Rahman RA, Nor GM, Ai Idrus SM, Ramli R. Maxillofacial trauma with emphasis on soft-tissue injuries in Malaysia. *Int J Oral Maxillofac Surg.* 2007;36(9):797-801.
4. Bianchini EM, Moraes RB, Nazario DA, Luz JG. Terapêutica interdisciplinar para fratura cominutiva de côndilo por projétil de arma de fogo – enfoque miofuncional. *Rev. CEFAC.* 2010;12(5): 881-8.
5. Martini MZ, Takahashi A, Oliveira Neto, HG, Carvalho Júnior JP, Cúrcio R, Shinohara EH. Epidemiology of mandibular fractures treated in a Brazilian level I trauma public hospital in the city of São Paulo, Brazil. *Braz Dent J.* 2006;17:243-8.
6. Montovani JC, Campos MP, Gomes MA, Moraes VR, Ferreira FD, Nogueira EA. Etiologia e incidência das fraturas faciais em adultos e crianças: experiência em 513 casos. *Braz J Otorhinolaryngol.* 2006;72:235-41.
7. Macedo JL, Camargo LM, Almeida PF, Rosa SC. Perfil epidemiológico do trauma de face dos pacientes atendidos no pronto-socorro de um hospital público. *Rev Col Bras Cir.* 2008;35:9-13.
8. Bakardjiev A, Pechalova P. Maxillofacial fractures in Southern Bulgaria – a retrospective study of 1706 cases. *J Craniomaxillofac Surg.* 2007;35(3):147-50.
9. Ogunlewe MO, James O, Ladeinde AL, Adeyemo WL. Pattern of paediatric maxillofacial fractures in Lagos, Nigeria. *Int J Paediatr Dent.* 2006;16:358-62.
10. Maliska MC, Lima Júnior SM, Gil JN. Analysis of 185 maxillofacial fractures in the state of Santa Catarina, Brazil. *Braz Oral Res.* 2009;23(3):268-74.
11. Oliveira DM, Vasconcellos RJ, Laureano FJ, Cypriano RV. Fracture of the coronoid and pterygoid processes by firearms: case report. *Braz Dent J.* 2007;18(2):168-70.
12. Sakae EK, Barroso, MV, Hiraki PY, Moura T, D'Agostinho L. Tratamento conservador de fratura cominuta de mandíbula ocasionada por arma de fogo: relato de caso. *Rev Soc Bras Cir Craniomaxillofac.* 2008;11(3):16-16.
13. Bianchini EM. Ajuda fonoaudiológica. In: Bianchini EMG. organizadora. *Articulação temporomandibular: implicações, limitações e possibilidades fonoaudiológicas.* 2a ed. Carapicuíba: Pró-Fono. 2010; p.321-61.
14. Marzotto SR, Bianchini EMG. Anquilose temporomandibular bilateral: aspectos fonoaudiológicos e procedimentos clínicos. *Rev CEFAC* 2007;9(3):358-66.
15. Laverick S, Patel N, Jones DC. Maxillofacial trauma and the role of alcohol. *Br J Oral Maxillofac Surg.* 2008;46:542-6.
16. The Cochrane Collaboration. *Cochrane Handbook for Systematic Reviews of Intervention.* 2011.
17. Gerlach KL, Schwarz A. Bite forces in patients after treatment of mandibular angle fractures with miniplate osteosynthesis according to Champy. *J. Oral Maxillofac. Surg.* 2002;31:345-348.
18. Murakami K, Yamamoto K, Sugiura T, Yamanaka Y, Kirita T. Changes in mandibular movement and occlusal condition after conservative treatment for condilar fractures. *J. Oral Maxillofac. Surg.* 2009;67:83-91.
19. Kondoh T, Hamada Y, Kamei K, Kobayakawa M, Horie A, Iino M, et al, Seto K. Comparative study of intra-articular irrigation and corticosteroid injection versus closed reduction with intermaxillary fixation for the management of mandibular condyle fractures. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2004;98:651-6.
20. Niezen ET, Bos RR, Bont LG, Stegenga B. Complaints related to mandibular function impairment after closed treatment of fractures of the mandibular condyle. *J. Oral Maxillofac. Surg.* 2010;39:660-665.
21. Thoren T, Hallikainen D, Iizuka T, Lindqvist C. Condylar process fractures in children: a follow-up study of fractures with total dislocation of the condyle from the glenoid fossa. *J Oral Maxillofac Surg.* 2001;768-73.
22. Hlawitschka M, Loukota R, Eckelt U. Functional and radiological results of open and closed treatment of intracapsular (diacapsular) condylar fractures of the mandible. *J. Oral Maxillofac. Surg.* 2005;34:597-604.
23. Kaplan BA, Hoard MA, Park SS. Immediate mobilization following fixation of mandible fractures: a prospective, randomized study. *Laryngoscope.* 2001;111(9):1520-4.
24. Rutgers JP, Kruizinga EH, Rosenberg A, Koole R. Functional results after conservative treatment of fractures of the mandibular condyle. *Br J Oral Maxillofac Surg.* 2007 Jan;45(1):30-4.
25. Throckmorton GS, Ellis E 3rd, Hayasaki H. Jaw kinematics during mastication after unilateral fractures of the mandibular condylar process. *Am J Orthod Dentofacial Orthop.* 2003;124(6):695-707.
26. Gerbino G, Boffano P, Tosco P, Berrone S. Long-term clinical and radiological outcomes for the surgical treatment of mandibular condylar fractures. *J Oral Maxillofac Surg.* 2009;67:1009-14.
27. Sforza C, Tartaglia GM, Lovecchio N, Ugolini A, Monteverdi R, Gianni AB. Mandibular movements at maximum mouth opening and EMG activity of masticatory and neck muscles in patients rehabilitated after a mandibular condyle fracture. *J Craniomaxillofac Surg.* 2009 Sep;37(6):327-33.
28. Throckmorton GS, Ellis III E, Hayasaki H. Masticatory motion after surgical or nonsurgical treatment for unilateral fractures of the mandibular condylar process. *J Oral Maxillofac Surg.* 2004;62:127-38.
29. Jensen T, Jensen J, Norbolt SE, Dabt M, Lenk-Hansen L, Svensson P. Open reduction and rigid internal fixation of mandibular condilar fractures by an intraoral approach: a long-term follow-up study of 15 patients. *J Oral Maxillofac Surg.* 2006;64(12):1771-9.
30. Caldas IM, Magalhães T, Afonso A, Matos E. Orofacial damage resulting from road accidents. *Dent Traumatol.* 2008;24(4):410-5

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