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

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.
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 injury. The primary cause of maxillofacial fractures is road accidents. However, increased interpersonal violence 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 fractures is higher in men than in women. However, over the past few decades, the incidence has increased in women aged below 40 years, with a lower incidence in children and individuals older than 40 years.

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 in 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 sequelae.

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 Handbook 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.

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 and the analysis of treatment outcomes and facial trauma-related complaints (poor or

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**Table 1. Summary of the evaluated studies**

<table>
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<th>Reference</th>
<th>Aim</th>
<th>Sample</th>
<th>Evaluated parameters and treatment controls</th>
<th>Results and Conclusions</th>
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<tr>
<td>Gerlach and Schawarz, 2012</td>
<td>To assess the maximum bite force in patients with mandibular angle fractures that were surgically treated</td>
<td>Twenty men and two women with mandibular angle fractures aged 27 to 38 years. Age and gender-matched controls</td>
<td>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).</td>
<td>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.</td>
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<td>Murakami et al., 2009</td>
<td>To analyze the mandibular movement and the occlusal condition of patients who underwent conservative treatment for unilateral condylar fractures</td>
<td>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</td>
<td>Evaluated parameters: mandibular movement. The participants were evaluated 3 and 6 months after treatment initiation.</td>
<td>After 6 months, the maximum mouth opening was normal in the patient group, 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.</td>
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<td>Kondoh et al., 2004</td>
<td>To compare closed reduction + intermaxillary fixation + intra-articular irrigation (corticosteroid) and closed reduction + intermaxillary fixation without intra-articular irrigation for unilateral condylar fractures</td>
<td>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.</td>
<td>Evaluated parameters: radiological findings, jaw function, and pain in the TMJ. After 6 months of treatment, 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.</td>
<td>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.</td>
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<td>Study</td>
<td>Objective</td>
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<td>Niezen et al., 2010&lt;sup&gt;10&lt;/sup&gt;</td>
<td>To analyze the relationship between impaired jaw function after closed treatment of mandibular condylar fractures.</td>
<td>Seventy-three men and 41 women. Average age, 28 years.</td>
<td>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.</td>
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<td>Thorén et al., 2001&lt;sup&gt;21&lt;/sup&gt;</td>
<td>To investigate the incidence of functional impairment and radiological findings related to the TMJ in children with condylar fractures that were not surgically treated.</td>
<td>A total of 138 children with uni- or bilateral condylar fractures.</td>
<td>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.</td>
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<td>Hiwitschka et al., 2005&lt;sup&gt;22&lt;/sup&gt;</td>
<td>To evaluate and compare the results of open and closed treatments for intra-capsular fractures.</td>
<td>Forty-three patients were divided into two groups: 1) Sixteen (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.</td>
<td>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.</td>
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<td>Kaplan et al., 2001&lt;sup&gt;23&lt;/sup&gt;</td>
<td>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.</td>
<td>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.</td>
<td>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.</td>
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<td>Rutges et al., 2006&lt;sup&gt;24&lt;/sup&gt;</td>
<td>To investigate the functional outcome of patients who undergo conservative treatment of condylar fractures.</td>
<td>Twenty-eight patients (25 men and three women) with condylar fractures. Average age: 30 years. Average time of fracture: 3 years.</td>
<td>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.</td>
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<td>Study</td>
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<td>Throck-morton et al., 2003</td>
<td>To compare masticatory movements between patients with treated unilateral condylar fractures and healthy controls</td>
<td>Eighty-one men with condylar fractures aged 16 to 70 years</td>
<td>Recording of mandibular movements and computational analysis of chewing</td>
<td>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. 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.</td>
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<td>Gerbino et al., 2009</td>
<td>To evaluate the efficacy and safety of a therapeutic method</td>
<td>Thirty-three men and 17 women with uni- or bilateral condylar fractures</td>
<td>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</td>
<td>A total of 12% patients exhibited facial muscle paralysis, which was permanent in 4%. Clinical and radiological evaluation revealed satisfactory recovery of facial symmetry and excellent recovery of facial function. Few patients complained of symptoms related to TMD. 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. Surgical treatment associated with postoperative functional therapy was found to promote the recovery of occlusion, function, and facial symmetry.</td>
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<td>Sforza et al., 2009</td>
<td>To quantitatively assess rotational and translational jaw movements during maximum mouth opening in patients who were successfully rehabilitated after condylar fractures</td>
<td>Eight men and one woman with condylar fractures</td>
<td>All patients received functional therapy for approximately 40 days after surgery.</td>
<td>Patients presented with a significantly lower range of mouth opening compared with controls, with a greater decrease in the vertical displacement component. Percentage of rotational movements was significantly higher in patients (82%) than in controls (77%). During maximum dental intercuspation, patients showed higher asymmetry and significantly higher torque and contraction values for the sternocleidomastoid muscle. Total recovery of opening movements could be achieved, although the rotational and translational components of this movement were altered.</td>
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<td>Study</td>
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| Throck-mortonet al., 2004    | 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          | 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. |
With regard to the treatment approach (surgical or conservative), five studies\(^7,10,20,26,29\) involved surgery, three\(^8,21,24\) 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\(^7,20,22,26\), with a higher incidence of facial trauma in men\(^7,8,20,24,27,29,30\). Only two studies included children\(^21,30\). Most studies did not use control groups\(^20,23,26,28,30\). 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\(^16-21,23,28-30\) and performed clinical examinations\(^20,21,23,26,28,30\), followed by radiological\(^8,13,21,22,28,29\), physical\(^8,20,29\), psychological\(^29\), and axiographic\(^29\) 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 years\(^23\) 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\(^3,8,26\) improved after treatment and over time, two showed an improved occlusal contact area\(^3,8,26\), 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 several studies\(^8,24,27,30\). However, some of these studies\(^8,27,30\) reported a lower range of mouth opening in patients than in controls. In one study\(^20\), the maximum mouth opening was not restored to normal.

With regard to jaw mobility, one study\(^8\) observed a limited recovery in jaw mobility. In four studies\(^26-22,30\), 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 study\(^9\) 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


