Mandibular Distraction Osteogenesis

A systematic review of literature

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Abstract—Bone Mandibular Distraction (BMD) is a surgical procedure for the gradual elongation of the bone tissue. Currently, the acquired BMD boom to be an effective treatment that provides a better quality of life for the patient. The region where this method is applied, craniofacial area specifically in the mandibular region. The BMD is the gradual lengthening of the mandible through their cortical osteotomy. The BMD itself consists of three periods: 1) Latency period. It is determined by the time that is expected to start the distraction. It begins a slow and steady pace. 2) Period of distraction. During this phase, the bone segments are separated by small increments. This stage takes place at a slow, steady rate and is obtained as a result of the new bone formation at the osteotomy site. 3) Period of consolidation. It occurs when the bone segments are carried forward end position. The duration of this period is 4-8 weeks. Finally, the distractor is removed. This technique provides excellent results in the treatment of patients with mandibular development problems.

Keywords: Bone Mandibular Distraction, Osteogenesis.

I. INTRODUCTION

Surgical techniques and technology are continuously evolving osteogenic distraction application in various medical areas. Medical specialists in this discipline note that this type of treatment in patients with deficiencies and deformities complex craniofacial (CMF) today necessary.

Mandibular Distraction Osteogenesis (MDO) is the method used to achieve the gradual lengthening of mandibular bone and surrounding tissue.

Within the area craniofacial (CMF), surgical techniques and technology are constantly evolving. The MDO has a boom to be an effective surgical treatment and not risky for patients. The application of the MDO notes necessary and immediate changes in the CMF structures resulting aesthetic and functional improvement [1-6].

The application of the osteotomy was established in the nineteenth century when Malgaine described the concept of external developments in the treatment of composite patellar fractures [7]. The Osteogenesis Distraction (OD) was first used, by Italian Alessandro Codivilla in 1905 [8, 9]. Alessandro was the researcher who first reported a lengthening of the femur.

In 1927, Abbott [36] applied the same concept in the elongation of a tibia. The OD was not successful in its early because doctors reported cases with a high incidence of complications. These published complications were a recurrent infection, necrosis, and the unpredictability of mineralization [13].

After several years, this technique was taken up by Dr. Ilizarov in 1950 [10]. Ilizarov contributed explaining biological and mechanical principles in the formation of new bone [37]. He demonstrated that gradual traction creates stress that stimulates the regeneration and growth of living tissues. The investigators named this gentle traction "the stress-strain law [35, 39]."

In 1973, Snyder [11] described the technique of the OD and conducted the first experimental study in the jaw of a dog [40]. In 1992 Mc. Carthy [42] they reported the first DO applied in pediatric patients with mandibular hypoplasia [37, 40] and 1995 applied Molina and Ortiz Monasterio[13] BD in patients with unilateral and bilateral mandibular deficiency [37, 40]. They used monodirectional and bidirectional extraoral distractors to elongate branch and mandibular body in patients with HFM and bilateral mandibular hypoplasia. They also observed and reported significant benefits in all cases.

In 1995, César Guerrero et al. presented a management protocol to lengthen the jaw. They used unilateral or bilateral intraoral devices and performed well results [43].
In 2001, McCarthy [7] reported 11 years of clinical and experimental experience with MDO. He concluded that this treatment, the level of the CMF skeleton might serve as an adjuvant in the formation of endogenous tissue [35]. Today, many investigations are done to assess the use and operation of the MDO. Thus, the current research literature recommend the utilization of the MDO as an efficient method, with fewer risks and complications than traditional bone grafts and osteotomies [39 - 41].

The researchers took to the jaw as one of the first elections for bone distraction in the facial skeleton as its easy accessibility. Also, radiographs can easily document the changes and CT scans. The MDO allows surgery at an early age, without surgery or prolonged hospital stadiums [12].

II. ETIOLOGY

Before treatment of distraction osteogenesis, a thorough clinical examination to know the type of deformity is necessary. For this test, it is considered that there are many causes of a deficiency in the Mandibular Development (MDD) [22] among them we can find:

A) Pierre Robin sequence.

According to Pierre Robin DDM is a present at birth is associated with many faults caused by a cascade of events initiated by a malformation [32]. The DDM, was described by the French dentist Pierre Robin in 1923 and 1934 [3]. The condition is characterized by the triad micrognathia, glossoptosis, cleft palate and airway obstruction. Following micrognathia, the tongue moves backward and produces respiratory obstruction. This blockage can cause hypoxemia, hypercapnia, pulmonary edema, difficulty feeding, vomiting, malnutrition, aspiration pneumonia and occasionally death. The mortality rate associated with this obstruction is reported close to 40% 31 and was directly related to the degree of respiratory distress in the newborn. The prevalence varies between 1 in 8,500 births, both female and boys [17–21, 33-34]. The MDO is a very efficient alternative to tracheotomy in patients with obstruction of the airway in neonatal Pierre Robin Sequence (PRS) [25–31].

B) Treacher Collins syndrome (TCS).

Berry in 1889 described the TSC also known as mandibulofacial dysostosis. The TSC is a disorder of craniofacial development [23]. The main cause of TSC is an alteration in the development of facial structures derived from the first and second branchial arch [24]. The researchers presented the TSC as a prevalence of 1 in 50,000 live births, and they characterized this syndrome by various anomalies of the pinna, anti-mongo-lianas colobomas palpebral fissures, and lower eyelid. The TSC carries macrostomia, abnormal insertion of the scalp line, lack of tabs in the medial third of the lower eyelid, mandibular hypoplasia, and facial bones.

C) Sleep apnea / obstructive hypoventilation (SA / OHV):

SA / OHV are an apnea episode per hour of more than 10 seconds, less than 87% saturation, and increased CO₂ [19-20]. This anomaly presents a high risk of neonatal death due to respiratory obstruction. This syndrome can be treated by the MDO implementation resulting in a good osteogenesis. This treatment is well tolerated by the patient and has a short period, reports good results without recurrence [21]. Ignorance of the MDO to settle definitively apnea is a risk factor favoring the high morbidity and mortality in neonatal units [19].

There are two broad groups of devices for MDO available in the market: a) Extra-Oral (MDO-EO) DOM. A DOM-EO they are associated with excellent results; b) Intra-Oral MDO (MDO-IO) devices have reduced flexibility during placement [14-17]. Orthopedic physicians use the MDO-EO for small areas or working minimum volumes mounted outside the patient. These have the advantage of easy handling and removal thereof. The MDO-EO has the disadvantage of causing a scar on the patient.

Intraoral MDO (MDO-IO) device is more aesthetic than others are; however, it has two major drawbacks. The MDO-IO leaves patients percutaneous scar and the need for a second operation for removal of this scar [47].

The outcome depends on the vectors of the DOM ready by the surgeon and controlling activation of the distractor. This provision makes it a mechanism directed or guided. The type of mandibular hypoplasia there influences the decision on the kind of vector. If a vertical branch deficiency occurs, the vector standing upright at 90°. Orthopedic physicians place when there is a severe deficiency of the mandibular body vector horizontally, and they select the oblique vector when there is a deficiency in both the branch and the mandibular body.

III. BIOLOGY OF OD

Biological principles are as a basis the OD for bone repair. Disruption of cortical occurs due to a migration of inflammatory cells and initiating a bruise. As the OD progresses, a vascular reaction with the appearance of mesenchymal cells and the synthesis of collagen type I. It is observed, then sets a bridge fibrovascular collagen fiber and increases their density and is oriented along the axis of distraction. Mineralization starts between the tenth to fourteenth days at the edge of the osteotomy. While in the central area, there is an "area of fibrous tissue". The bone spicules replace the collagen knots and gradually close after distraction. Thus, ossification originates laterally and centrally progresses through four stages: the area of fibrous tissue, the area of bone formation, remodeling area and the area of mature bone [44-48].

He is known as distraction osteogenesis maxillofacial surgical procedure designed to treat deficiencies in the growth and development of bones face with involvement in the aesthetic, functional disturbances (breathing, chewing)
and psychological, is performed using elongation and progressive mobilization advancement at the expense of, after an initial osteotomy distractor apparatus. It is postulated as one of the best options for the advancement of the midface and the mandible.

The DOM is constituted by stages which are:

1. Osteotomy and placement of the distractor.

2. Latency period: The time is expected to start distraction.

3. Period of activation—application of distraction forces. This distraction is started at a slow and steady pace. Bone segments are separated by small increments; while induction of new bone formation is performed in the gap. The goal is to obtain the desired elongation. This objective which is achieved when the bone segments are held securely in its final position.

4. Period of Consolidation: The regeneration and bone remodeling segment is obtained during this period of 4-8 weeks. During the consolidation phase, bone remodeling begins, and fibrous tissue matures over time in the primary bone similar to native bone tissue. APPLIANCE DISTRACTOR serves as a splint in this period and subsequently removed.

Because the distraction progresses at a slow pace, the related muscles, blood vessels, nerves and mucosa also lengthen.

This concomitant expansion of soft tissues is one of the main advantages of distraction.

IV. CONCLUSIONS

1. It is clear that the results of distraction or bone induced generation are much superior to those obtained by osteotomy and bone grafts reasons. As are predictable, safe and efficient thus fulfilling the goal of restoring function to patients treated through DOM.

2. It is a relatively simple procedure that can be performed as outpatient surgery but their planning and control requires the involvement of a multidisciplinary team involved in the philosophy of this procedure. So it should be considered as a chronic treatment deficiency in a patient with the jaw.

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