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Mandibular Reconstruction in Pediatric Patients by Fibula-Free Flap

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Abstract

Objective: The aim of this study was to evaluate the mandibular reconstruction in pediatric patients by fibula-free flap.

Materials and Methods: The study was conducted in 12 pediatric patients, aged 8 to 13 years, who presented mandibular bone defects due to benign pathologies and met criteria for fibula-free flap reconstruction. These defects were classified and underwent surgery with prior informed consent by their parental consent form. Previous computed tomography and immediate and late postoperative control were available.

Result: Mandibular reconstruction was performed by taking and placing a free flap of double barrel fibula technique, obtaining as results in the postoperative tomographic analysis, with the evidence of the vascularization of the reconstructed tissues, which maintain the vertical and horizontal bone dimensions over time, with a decrease of 0.2 mm on average, these being acceptable and expected reabsorption.

Conclusion: The fibula-free flap represents the ideal treatment for mandibular reconstruction in pediatric patients with mandibular defects due to benign pathologies, achieving immediate reconstruction and facial symmetry, maintaining functions and returning psychosocial stability to patients, without associated morbidities.

Keywords: Mandibular reconstruction; Fibular free flap; Pediatric patients; Benign mandibular pathologies; Cone Beam tomography

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Introduction

The presence of tumors in pediatric patients has in general a low incidence, however, when it occurs, they cause damage modifying the development and growth of the face, generating physical, aesthetic and psychological alterations. Despite this, a large number of benign lesions have been reported at an early age and may be associated with systemic pathologies. The timely diagnosis will allow the adequate treatment decreasing the morbidities of tissues involved, the reconstruction varies from the use of autologous bone grafts, distraction osteogenesis and microvascular free flaps.

In pediatric patients, donor sites and the availability of free flaps are limited and a point to consider. However, autologous tissue is ideal for reconstruction in view of not being antigenic, having osteo-inducers, osteo-conductors and osteogenic properties [1]. In recent years, the transfer of autologous tissues has increased due to the development of better equipment, surgical techniques and understanding of the characteristics of the age groups, obtaining excellent aesthetic and functional results for being a biocompatible resource [2].

Currently, the care for the treatment of mandibular tumors in pediatric patients is bloc resection with wide margins to prevent the recurrence of pathologies, with immediate reconstruction with osteosynthesis material and free flap, thus providing favorable aesthetic and functional results in the patient. This is why it is one of the aspects to take into account in view of being in full growth and development [3,4].

The fibula is a donor site that presents ideal characteristics for mandibular reconstruction, where by preserving the periosteum, adaptation to the receptor site shows a success rate and its wide length and distant location allows the simultaneous approach of two teams at the same time.

Different studies report fibular bone regeneration at the level of the native site in pediatric patients, however, information regarding the use of free flap and protocol worldwide is scarce, therefore, the need to offer specialists in the area of maxillofacial surgery, new options for immediate reconstruction, as a basis for previous studies and demonstrate which is the most favorable protocol according to the requirements of patients. Therefore, the following study aims to evaluate mandibular reconstruction in pediatric patients using a fibula-free flap.

Materials and Methods

A field, descriptive and prospective longitudinal study was carried out, which describes 12 cases of pediatric patients, in an age range between 8 and 12 years, 6 male and 6 female, attended in the oral and maxillofacial surgery service of the University Hospital "Dr. Ángel Larralde, Barbula, Carabobo Venezuela, in the period from January 2017 to February 2022 with prior informed consent authorized by their representative; having as inclusion criteria patients who presented benign pathologies and their resection produced mandibular bone defect in body and mandibular branch, without systemic pathologies that met the criteria for fibula-free flap reconstruction.

There was availability of medical history, facial and intraoral photographic records, at different times to be evaluated; as well as cone beam computed tomography, with the New Tom software, in phases described as preoperative T0, immediate postoperative T1, late postoperative T2 to 2 years, with standardized measurements. The treatment and conduct towards patients by those involved was governed by the Venezuelan code of dental ethics.

The study was staged in three phases, where the first consisted of clinical evaluation, anamnesis and paraclinical studies, as well as imaging by cone beam computed tomography to establish the diagnosis, classification of mandibular defects postresection and surgical planning. In the second phase, given by the surgical act, mandibular resection and reconstruction was performed using a fibula-free flap. The third phase was the immediate postoperative evaluation and postoperative control of 2 years after the surgical intervention it was performed.

Results

The study included 12 cases of pediatric patients, diagnosed with benign pathologies, located in the mandibular region, who met all the inclusion criteria; these were in an age range of 8 to 12 years, the mean age was 10 years, in terms of sex distribution, 6 female patients and 6 male patients were included (Table 1).

The preoperative assessment included exhaustive interrogation, evaluation of the function of laterality, protrusion movements and mouth opening, phonation, swallowing and sensitivity of the affected area, multidisciplinary evaluation was carried out with relevant services such as pediatrics, nutrition and anesthesiology. Facial and intraoral photographic recording, measurements, dental impressions for the elaboration of bimaxillary splints were obtained for dental occlusion recreation and stability. Imaging was used for surgical planning to look at the extension of the lesion, resection approach measurements with safety margins and classifying the mandibular defect to be generated according to Boyd et al. and Urken et al. (Table 2).

Simple lower limb X-ray was used to assess bone tissue availability required for the fibula-free flap. All patients had a diagnosis of incisional biopsy prior to surgery.

Table 1: Enumeration of study sample according to age, sex, clinical diagnosis.

Px	Age	Sex	Diagnosis
1	11	F	Ossifying cement fibroma/aneurysmatic osseous cyst
2	10	F	Dentinogenic phantom cell tumor
3	9	M	Aneurysmatic bone cyst
4	12	F	Central granuloma of giant cells
5	8	M	Ossifying cement fibroma
6	12	M	Ameloblastic fibroma
7	8	F	Ossifying cement fibroid
8	9	M	Aneurysmal bone cyst
9	10	M	Dentinogenic ghost cell tumor
10	11	F	Fibromyxoma
11	12	F	Central giant cell granuloma
12	8	M	Fibromyxoma
Media	10	-	-

Table 2: Classification of defects, post mandibular resection.

Px	Boyd	Urken
1	LC	RBS
2	HC	CRBS
3	H	CRB
4	L	RB
5	LC	RBS
6	HC	CRBS
7	L	B
8	H	CR
9	HCL	CRBSB
10	H	CRB
11	L	RB
12	LC	BS

Surgical Technique

After monitoring and anesthetic induction by the anesthesiology service, nasotracheal intubation and balanced general anesthesia protocol is performed. Under previous asepsis and intra- and extraoral antisepsis, placement of sterile fields and infiltration of local anesthetic lidocaine 2% with epinephrine 1:80,000, in approaches areas. The lesion is delimited and fine needle aspiration is performed. The incision and dissection were made by planes to get through the lesion, osteotomy with proximal and distal safety margins, ligation of the vessels to prepare the recipient bed (Figure 1); The specimen is preserved for histopathological study and corroborate diagnosis.

A second surgical team, in simultaneous time, after partially bleeding partial emptying the leg with a lower limb tourniquet, an anatomical fibular marking is performed; flag lengthening is taking is planned based on the required measurements; Both the proximal and distal ends are 6 cm in length for the stability of the knee and ankle (Figure 2).

We proceed to the incision approach to take a fibula-free flap. Dissection is performed through the midline raphe, to preserve the peroneal vessels from the surface of the fibula and the deeper

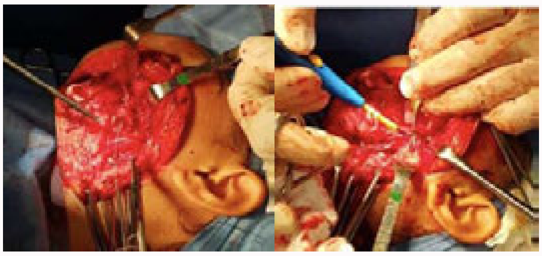

Figure 1: Intraoperative photographs, vessel ligation, receptor bed preparation.

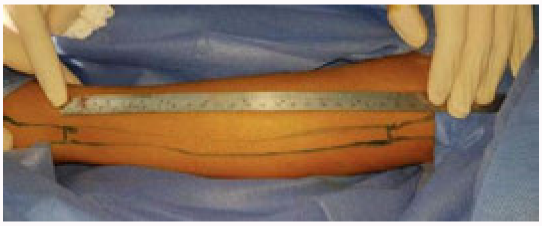

Figure 2: Intraoperative photography, lower limb marking.

Figure 3: Intraoperative photography, flap taking.

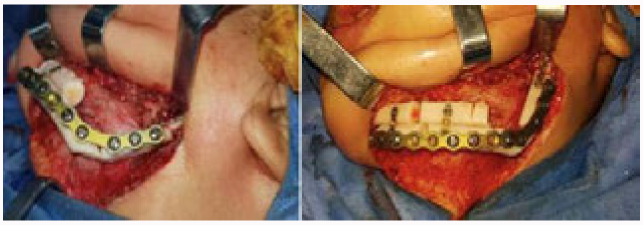

Figure 4: Intraoperative photography, double barrel.

posterior tibial vessels, dissection of the main pedicle is performed from distal to proximal. Osteotomies are made with reciprocating saw with protection of the vascular pedicle (Figure 3), the tourniquet is released in the lower limb soon after. It is recommended to maintain flap ischemia time less than 5 h to reduce the rate of flap loss and other complications.

The flap and the reconstruction plate system 2.4 are molded and fixed to the residual mandibular end, then the flap is fixed on its lateral surface. Barrel technique is performed to generate adequate height (Figure 4). Drilling and screw placement should be performed under continuous irrigation to avoid overheating and injury to the reconstructed bone.

With the surgical microscope in the operative field, microanastomosis is performed in ideal vessels, based on the extension and mandibular defect (Figure 5). Circummandibular wiring is placed for stabilization of the mandibular splint and tissue synthesis is performed by planes in both areas of surgical approaches (Figure 6).

Patients were discharged from the operating table without complications and during the 36-h hospital stay. Supervision and intraoral washings were performed, as well as extraoral and lower limb cures. Coverage for Gram-positive, Gram-negative and anaerobic bacteria was made for 10 days. The process of assisted and supervised ambulation was initiated at 36 h postoperative.

Table 3: Vertical measurements of mandibular body in anterior, middle and posterior area.

Px	T1			T2		
	A	M	P	A	M	P
1	14	14	14	13.6	13	13
2	16	16	15	15.8	15.8	15
3	14	15	14	13.5	14.5	13.5
4	13	14	14	13	13.8	13.8
5	12	13	13	11.8	12.8	12.8
6	14	14	15	14	14	14.5
7	14	14	13	14	13.7	12.7
8	13	13	12	12.4	12.5	12
9	14	14	15	14	14	14.6
10	16	16	16	15.7	15.7	15.7
11	13	13	12	12.6	13	12
12	14	14	15	14	13.6	14.6
Media	13.91	14.16	14	13.65	13.86	13.68
S.D.	1.16	1.02	1.27	1.20	1.05	1.20

Legend: T1: Immediate postoperative time; T2: 2 years postoperative time; SD: Standard Deviation
A: Mandibular body anterior area, M: Mandibular body middle area, P: Mandibular body posterior area

Table 4: Measures horizontal mandibular body.

Px	T1	T2
1	60	59.5
2	63	62.5
3	62	61.3
4	60	59.2
5	65	64.6
6	60	59.6
7	61	60.7
8	64	63.2
9	67	66.3
10	70	69.4
11	60	59.1
12	69	68.6
Media	63.41	62.97
S.D.	3.62	3.66

Legend: T1: Immediate postoperative time; T2: 2 years postoperative time; S.D: Standard Deviation

Table 5: Vertical mandibular branch measurements.

Px	T1	T2
1	40	39.5
2	42	41.4
3	40	39.5
4	39	38.5
5	42	41.6
6	40	39.6
7	42	41.4
8	41	40.6
9	45	44.4
10	44	43.6
11	39	38.5
12	43	42.4
Media	41.41	40.97
D.E.	1.92	1.90

Legend: T1: Immediate postoperative time; T2: 2 years postoperative time; S.D: Standard Deviation

In the postoperative evaluation, it consisted on facial and intraoral clinical assessment, which denotes mandibular facial symmetry achieved with functional maintenance, as well as occlusal stability; In the imaging findings, the position of the wiring, osteosynthesis material, as well as the flap and the double barrel bone graft in position (Figure 7, 8) were evaluated, maintaining the vertical and horizontal proportion of the portion of body and reconstructed mandibular branch ramus.

In reference to the assessment of the measurements of the mandibular body region, it was proposed to consider 3 vertical zones: Anterior, middle and posterior; where in the anterior region it was evidenced in T1 average measure of 13.91 mm in contrast with the same region in T2 of 2 years which the average was 13.65 mm; on the other hand, in the middle region of the mandibular body, in T1 on average it was 14.16 mm, resulting in T2 in 13.86 mm; ending

Table 6: Horizontal measurements of mandibular branch in upper, middle and lower area.

Px	T1			T2		
	U	M	L	U	M	L
1	7	7.5	7.5	6.4	7.1	7.5
2	8	8.3	8.3	7.8	8.3	8.3
3	7	7.6	7.6	6.5	7	7
4	7.5	8	8	7.3	7.9	7.8
5	7.8	8	8	7.4	7.6	7.6
6	7	7.7	7.7	6.5	6.9	6.9
7	7	7.6	7.6	6.4	7.2	7.2
8	7.5	8	8	7	7.6	7.6
9	7.5	7.9	7.9	7	7.2	7.2
10	8	8	8	7.4	7.4	7.4
11	8	8.5	8.5	7.6	8.4	8.2
12	8	8	8	7.5	7.5	7.5
Media	7.52	7.92	7.92	7.07	7.50	7.51
S.D.	0.43	0.29	0.29	0.49	0.48	0.43

Legend: T1: Immediate postoperative time; T2: 2 years postoperative time; S.D: Standard Deviation
U: Upper mandibular body area; M: Middle mandibular body area; L: Lower mandibular body area

with the posterior mandibular body region, where the vertical length measurement was 14 mm in T1 and 13.68 mm in T2; the stability achieved over time is evident in view of having an expected decrease in vertical bone length of 0.3 mm on average in the 3 regions evaluated (Table 3).

Regarding the horizontal longitudinal measurement of the mandibular body, a decrease in this length of 0.4 mm was observed on average, with the mean at T1 of 63.41 mm to be established at 2-year T2 at 6.97 mm; presenting this bone decrease by muscular and functional action, being in ideal range for its subsequent rehabilitation with implant-supported prosthesis (Table 4).

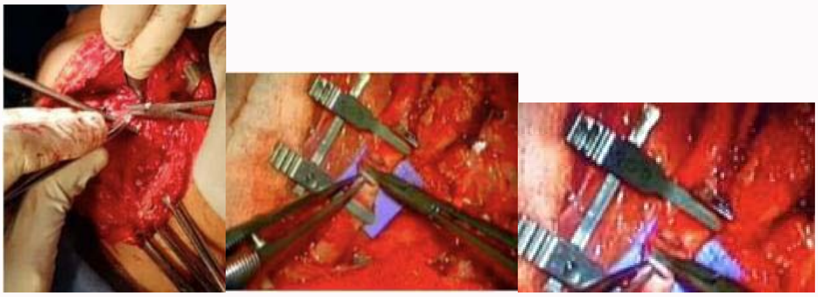

Figure 5: Intraoperative photography, anastomosis.

Figure 6: Intraoperative photography, tissue synthesis.

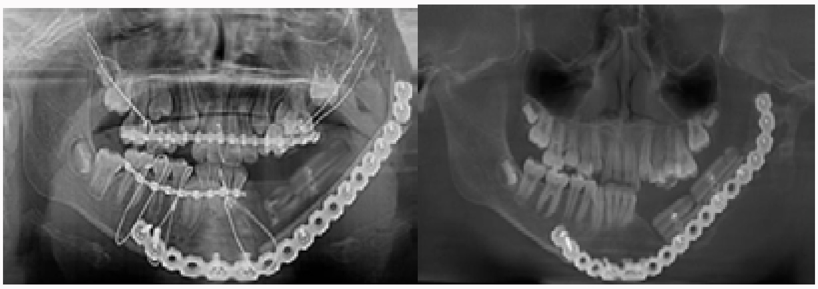

Figure 7: Postoperative panoramic X-ray.

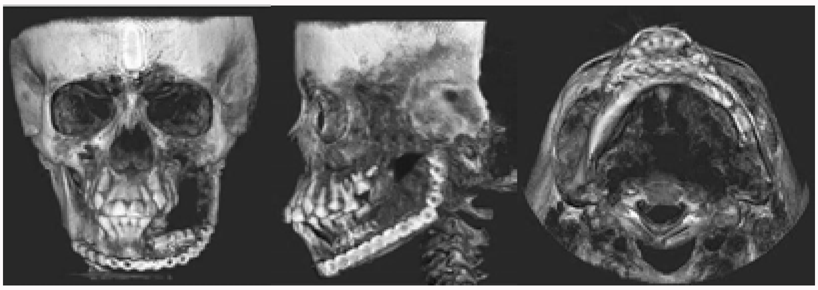

Figure 8: Cone Beam CT scan, 3D volumetric reconstruction.

Table 5 shows the dimensions of the reconstructed mandibular branch ramus, in terms of vertical length, showing a range of bone decrease of 0.4 mm on average, with an average of 44.41 mm at T1 and 40.97 mm at 2-year T2.

The dimensions of the mandibular branch were assessed in terms of horizontal length, divided into. Three portions: Upper, middle and lower, evidencing in upper portion in average T1 of 7.52 mm and in T2 of 7.07 mm; continuing with the middle portion, T1 was assessed with an average of 7.92 mm and T2 with a mean of 7.51 mm, observing an expected bone decrease of 0.5 mm (Table 6).

Discussion

Mandibular reconstruction in pediatric patients represents one of the most important challenges for specialists in oral and maxillofacial surgery, because it seeks to ensure success by returning function, adequate dental occlusion, mouth opening acceptable, contribution in phonation and swallowing, as well as the restoration of hard and soft tissues, returning the facial contour, therefore, facial symmetry, however, balance must be maintained in growth in the adolescent period [5-7].

Several surgical techniques have been described in the past, including the use of alloplastic material, pedicle flaps, bone grafts and vascularized free flaps of similar regions [8,9]. Warren, on the other hand, reflects that different flaps carry different problems, for example, prolonged postoperative pain, altered gait, damage to sensory nerves, delayed healing, unwanted fracture, bruising, among others. However, for the reconstruction of mandibular defects in pediatrics, fibula-free transfer makes it preferable. Troulis [10] and Progrel [11], concluded that free bone flaps are ideal for mandibular defects larger than 9 cm and that bone grafts were ideal for defects smaller than 9 cm. August et al. [12] showed that grafts larger than 9.9 cm were statistically associated with early graft failure. Bottini [13] and Schemith [14], point out that not only size matters, but also anatomical location, soft tissue status, age and concomitant conditions.

Posnick et al. in 1993 [15], reports that the free transfer of fibula allows the dissection of both sites in simultaneous time; minimal morbidity of the donor site, if the distal and proximal tissues are preserved avoiding ankle mortis, without affecting the growth of the extremities, with prompt ambulation after a short period of immobilization. Once the segment is obtained, it allows to reconstruct practically any mandibular defect, with osteotomies of total thickness in different areas that do not compromise the vascularity, different techniques can be performed such as double barrel to obtain the desired height and rigid internal fixation with miniplates [6,16-18].

Although without escaping possible complications, the fibula-free flap at its donor site includes flexion contracture, weakness, deformity, tibial fractures and proximal migration of the fibula [5,6,19]. None of these complications were reported by our patients, who had early onset of assisted and supervised ambulation.

Akakpo [20] in his study demonstrates that such flaps do not grow in the same way as the surrounding structures, leaving the possibility of facial asymmetry, in concord with Guo [17], the fibula does not grow concomitantly with the child, which is consistent with what has been reported in the literature. Temiz et al. [19] comments that the free fibula flap could adapt to the facial skeleton and has increasing potential. However, we could not find any study that identified specific factors that contributed to adequate growth or lack thereof, evidencing in our research that the stability in height of the flap bone tissue is maintained in the postoperative time 2 years, with minimal expected decrease of the reconstructed bone tissue.

As for the moment of reconstruction, immediate reconstruction was applied, in correspondence with what was reported by Pogrel [11], Warren [21] and Aksu [7]; allowing the best opportunity for accurate three-dimensional duplication of missing tissue and avoiding the morbidity and deformity inherent in delayed reconstruction in the recipient area. For his part, Troulis [10] differs by proposing protocol in stages, indicating that greater. Intraoperative duration is associated with increased blood loss, coagulopathies and hematomas, therefore, higher infection rates and wound dehiscence, as well as those reported by August [12].

However, our study documents factors that contribute to mandibular reconstruction in this pediatric patient population; where processes of this nature were not presented at any postoperative time, maintaining satisfactory results. Although many patients often require secondary surgery for dental rehab when they reach skeletal maturity, the psychosocial impact is diminished.

In relation to the above, based on the results obtained, it can be affirmed, the mandibular reconstruction successful, due to obtaining adequate mandibular dimensions post-resection of lesion with the chosen flap, considering the tomography measurements and facial photographs with improvement of the facial contour. It should be noted that, during the process, there were no complications during the controls.

Finalizing this is a strict protocol that requires thorough preparation, training of the surgical team, in addition to the collaboration of the patient to be treated and their representatives.

Conclusion

Pediatric mandibular reconstruction is an evolving challenge; Although there are different options for this reconstruction, the fibula-free flap allows the restoration of this mandibular complex, which is capable of healing as an adjacent native mandibular in growing patients and eventually resisting the load-bearing forces associated with chewing, providing sufficient bone material for the reconstruction of large defects, as well as performing osteotomies in altering its vascularization.

It is demonstrated with the findings described above, their analysis and discussion that this protocol proposed for pediatric patients in our study did not involve long-term complications. We must include in part of the preoperative planning, take into account the moment of dental development to generate the minimum alterations and consider maxillary and mandibular growth as part of the strategies for said treatment plan; thus, preserving normal occlusal relationships throughout the adolescence period; with accompaniment of mandibular growth and therefore maxillofacial growth, reducing facial alterations.

The age group should not be a problem in the decision of resection and reconstruction, fibula-free flaps are standard criteria for large resections in mandibular defects; therefore, safe to use in pediatric patients.

It is estimated that the objectives of the present research were satisfactorily achieved, since the diagnostic elements that led to the choice of fibula-free flap for the treatment of surgical management after resection of benign mandibular tumors were described. From the point of view of scientific knowledge, the analyses carried out and cited, give support to the application of this protocol, within the field of oral and maxillofacial surgery.

Finally, the application of this surgical management is an ideal option in view of the advantages of taking the flap, as well as the psychological improvement of the patient and family, in view of the restoration of facial symmetry and the consequent improvement of self-image; as well as complying with aesthetic and functional principles offering long-term stability in the treatment.

Recommendations

By virtue of the experience reported in the present study, this surgical management is recommended under the protocol of mandibular reconstruction by fibula-free flap, widely to healthcare centers, oral and maxillofacial surgery services, to be carried out with the technical planning protocols, as well as throughout the centers of university studies to continue generating continuous research.

A surgical team that has pediatric training is required to obtain optimal results and deepen scientific knowledge to corroborate the implications of surgical management under this technique.

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