Treatment of Alveolar Cleft Performing a Pyramidal Pocket and an Autologous Bone Grafting

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Abstract: Alveolar cleft repair is a debate topic in cleft lip and palate treatment.

The aim of this article is to analyze the outcomes and the advantages of the autologous bone grafting performed during the period between 1981 and 2006. In our plastic surgery unit, 468 patients with alveolar clefts have been treated. According to our protocol, the timing for the closure of the alveolar cleft ranged from 7 to 11 years (mean, 9.4 years). Autologous bone was taken from the skull in the 45% of patients, from the iliac crest in 35% of cases, and from the chin in 20% of cases. The surgical technique of creating a pyramidal pocket to secure the bone graft was central to achieving a good result. The postoperative evaluation of the results, using clinical criteria and three-dimensional computed tomography, allows us to assert that we obtained optimal results in 50% of treated cases, good results in 40%, sufficient in 4%, partial failure in 5.4%, and complete failure in 0.6%.

Key Words: Bone graft, alveolar cleft, pyramidal pocket

(MATERIALS AND METHODS)

Since 1981, so far 468 operations of autologous bone grafting have been performed to repair alveolar cleft. Although some surgeons treat the alveolar cleft in the neonatal period, whereas others prefer to operate for the first time at 8 to 10 years. Big discrepancies of views also exist surrounding surgical methodology. For example, during the early surgery, what anatomic structure should be dissected? Should the peristomeum be included in the mobilization? What type of material should be inserted into the bone gap? Homologous, alloplastic material, or autologous graft? And if the autologous material is chosen, from which part of the body should it be taken? Even in this case, the ideas are the very different. Should we respect the autarky of the cephalic extreme and harvest bone only from the skull or from the chin, or can we harvest from the costal bone? Or can we still use the iliac crest, or even further down to the tibia? In addition to these questions and many others, there is a lot of confusion regarding the terminology. For example, the term “secondary grafting” is misleading because it implies that a “primary grafting” has been performed. Why is it called secondary when in reality, no operation has been performed before?

Currently, particularly through the evaluation of long-term results, the late surgical procedure is used the most. The possible interference with facial growth was the reason for delaying the bone graft after the second childhood, although the optimal age for this procedure is still debated. Many centers are currently running late bone graft during the cuspid eruption, usually at an age between 7 and 11 years. The growth of the maxilla is mostly complete at the age of 8 years. Negative effects on facial growth have not been highlighted performing the bone grafting at this age. In addition, the migration and eruption of cuspsids through the grafted bone seem satisfactory. Since 1981, our protocol for the treatment of alveolar cleft provides late autologous bone grafting, performed at an age between 7 and 11 years. We performed 468 operations of autologous bone grafting to alveolar cleft. The first cases have been treated using the iliac crest. Since 1983, we have been harvesting from the skull. Recently, the donor sites included the chin. The objectives of our current protocol are as follows: to allow the closure of nasolabial fistula, to create stability and continuity of the upper dental arch, to improve the support of the teeth near the cleft, to allow the eruption of the cuspid in the cleft area after bone grafting, to allow the orthodontic movements into the transplanted bone, to facilitate oral hygiene, to reconstruct a normal shape of the pyriform aperture to support the base of the nasal pyramid, to eliminate the chronic inflammation of nasal mucosa due to fluid regurgitation, and to allow the rehabilitation of prosthesis, when necessary, either through traditional prosthesis or dental implants.

We analyzed the experience of the Plastic Surgery Division at Bologna University from 1981 to today and evaluated the results and choices that we implemented.

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According to our protocol, the timing for the closure of the alveolar cleft should range from 7 to 11 years (mean, 9.4 years). The surgery is performed after the completion of 80% of the development of the jaw, before or during the eruption of permanent cuspid. All patients receive autologous bone graft: in 45% of cases (178 patients), the bone was harvested from the skull, in 35% (142 patients) from the iliac crest, and in 20% (90 patients) from chin.

**Surgical Technique**

**Preparation of the Pyramidal Pocket**

The preparation of the pocket that will secure the bone graft must be very accurate, and we consider it a key point for therapeutic success. All patients receive the same technique to achieve a hermetic closure. At the end of the procedure, the pocket will look like a pyramid (Fig. 1A):

1. The anterior wall is the vestibular plan, a mucoperiosteal flap.
2. The superior wall is the nasal plan.
3. The lower wall is the palatal fibromucosa.
4. The posterior site is the apex of the pyramid, where the upper and the lower planes meet; and
5. The lateral walls are the alveolar cleft bone.

To achieve a pyramidal pocket, we perform an incision in the minor segment, along the vertical edge of the cleft in the craniocaudal direction on the border between the vestibular adherent gingiva and the palatal gingiva (Fig. 1B1).

Then incision is made at the gingival sulcus on the periodontal ligament surface, distally following the contour of 3 to 4 dental elements (Fig. 1B2). The incision continues obliquely with an acute angle cranially and toward the front (back cut) for 8 to 10 mm (Fig. 1B3). This incision allows the future flap to move toward the median line that is necessary to close the cleft on the vestibular side.

After this incision, the dissection continues to the full-thickness mucoperiosteal flap. The same technique is then performed in the area of the major segment. On this site, the mucoperiosteal flap is shorter and without back cut because it is the flap of the small fragment that will advance on the medial line to close the gap of the cleft and not vice versa (Fig. 1C). This will be the anterior wall of the pyramid.

Continuing the incision in the craniocaudal direction on the border between vestibular mucosa and palatal fibromucosa, we dissect the nasal mucosa. The dissection and separation of this from the lateral side are performed to get the mucosa to reconstruct the nasal plan and form the roof of pocket. This is the superior wall of the pyramid (Fig. 1D). The dissection of palatal fibromucosa is now possible and will form the inferior wall of the pocket (Fig. 1E). The suture should be accurate, and the mobilized flaps should not be in tension and with a good blood supply (Fig. 1F).
Bone Harvesting

For bone grafting the alveolar cleft using bone from the skull, we need to harvest the external cortical bone of the diploe, leaving the internal cortical bone intact. The parietal region is the right area for harvesting the calvarial bone.

After running a small incision in the scalp and undermining the periosteum, we harvest the cortical bone. We can use many different instruments: cranial drills and the osteotome of Hendel or a simply drill. The graft is taken from spongious and cortical bone.

We prefer to use an oscillating saw (Fig. 2A) because it is, in fact, easy to perform osteotomy lines on the external cortical bone and we can delimitate the area of the cortical bone graft with the osteotomies according with our needs. Then with a curved osteotome, we can split the external from internal diploe (Fig. 2B). In many cases, we can also harvest a good quantity of cancellous bone. If we need a lot of bones, it is better to divide the donor site into small places. Same time exposure of the dura mater may occur.

The technique of bone harvesting from the iliac crest, well described by Tessier, involves an incision of the skin behind the upper anterior iliac spine along the iliac crest, with the length of approximately 3 to 4 cm, depending on the amount of bone required. We then expose the crest. The harvesting (Figs. 3A, B) is performed in the medial part of pelvic bone, preserving muscular vascular and nervous structures. The iliac crest is a generous donor site of bone and can be taken in large quantities, is spongious, and is of excellent quality. The harvesting from the iliac crest of minor quantity of bone can also be made by a minimum incision using a special cylindrical drill, which is inserted and extracted in the context of bone.

The bone graft from chin symphysis (Fig. 4) is an easy technique and presents the advantages of being in the same operative field as the alveolar cleft. It presents the risk of damage to the roots of the inferior frontal teeth and a possible damage of mandibular nerve and also gives a quantity of cortical and spongious bone sufficient to repair a small or medium unilateral cleft, but insufficient for a large or bilateral cleft.

Positioning of Bone Graft in the Pocket

The next phase requires the placement of bone into the pocket previously set (Fig. 5). In cases of bilateral cleft, it is often necessary to use microplates to solidify the premaxilla and the bone graft (Fig. 6). At the same time, it is also useful to use fibrin glue for keeping the bone chips together. The last phase of the surgery involves the suture of mucoperiosteal flaps that are sculpted at the beginning of the surgical technique.

RESULTS

The postoperative evaluation of the results is made using clinical criteria and endoral radiography, orthopantomography, and teleradiography. The evaluation has been made at 3, 6, and 12 months after surgery. In the last 82 cases, three-dimensional computed tomography has been included that allows to assess more accurately the volume of bone graft.

In our evaluation, we considered:

1. The condition of vestibular as well as nasal and palatal mucosa: how it healed, its color, and its mucosal morphology.
2. The height of interdental bone compared with normal site (parameter for which is given a score from 1 to 3).
3. The thickness of the alveolar bone: (a) higher than 6 mm, (b) from 4.5 to 6 mm, and (c) less than 4.5 mm (all the measurements have been taken in the most subtle area); and
4. Height of the nasal floor: “N” if the same height as compared with healthy contralateral, “n” if lesser or insufficient.

The result was considered optimal (50% of treated cases) when patients showed a clinical closure of cleft, associated with objectivity at the radiography (reconstruction only 1 mm below the normal alveolar bone, with thickness of alveolar bone sufficient to receive a fixture for dental prosthesis, a nasal floor in a good level, even if the shape of pyriform aperture was asymmetric). The result was considered optimal also if in the cleft, the eruption or orthodontical migration of teeth was possible. The result was considered good when there was a clinical closure of alveolar cleft, if the height of grafted bone was lowest of more than 1 mm than normal alveolar bone, and if the thickness was not sufficient to receive a fixture (40% of treated cases). The result was considered sufficient if the fistula was closed and continuity of maxillary bone restored in the presence of a thin bony bridge without functional compromising of the possibility of a traditional reconstruction with prosthesis (4% of treated cases).

We observed partial failure of the methodology in 5.4% of cases when the clinical closure of fistula was obtained, but loss of bone grafted and lacking continuity of the maxillary arch were observed. We considered loss of bone grafted and reopening of fistula a total failure, which, in our series, was 0.6%.

**DISCUSSION**

In common language, repair of alveolar cleft is called primary, when early repair is performed during or immediately after the intervention of cheiloplasty, or secondary repair, when it is performed later, during the period of transitional dentition, before the cuspid or lateral permanent incisors eruption between 7 and 12 years. In our experience, the methodology illustrated in this article seems to be the best for a better patient outcome for the following reasons. We believe that at the age of 8 to 9 years when the growth of the maxilla has largely occurred, it is essential to insert autologous bone in the alveolar cleft. The autologous bone is considered the criterion standard; it is neovascularized and shows a high degree of taking.

The spongious bone leads to a more rapid healing of the bone defect if compared with the cortical bone because it activates the osteogenesis and contributes toward a more rapid vascularization. The cortical bone must be replaced by host tissue before it can take hold. The grafts that are predominantly composed of fragments of spongious bone are more quickly vascularized than larger fragments, but paradoxically, the same small fragments cannot be recognized as bone and undergo a process of resorption. Moreover, the small fragments or bone powder cannot be mechanically fixed.

Regarding the donor site, the skull is an excellent donor region for the large availability of bone especially for cortical bone; it is close to the treated area, the least morbidity (not visible residual scar, covered by hair, minimal residual bone depressions). It is a painless procedure. The bone of the skull has the same origin of the alveolar cleft (autarky law).

The iliac crest offers a wide availability of spongious bone, especially in patients older than 10 to 12 years; the harvesting is technically easy in skilled hands, and the morbidity is extremely low. It does not leave morphologic deficit, and the scar is not visible.
It is a painful procedure. If performed early in childhood, it may create growth problems.

The mandibular symphysis is a place for harvesting bone grafts for surgery of facial skeleton but has a limited source if compared with the others. It is successfully used in the case of unilateral cleft. The mandibular bone has the advantage of maintaining more volume with a lower degree of reabsorption. The harvesting is also technically easy and is done in the same operative field. This donor site presents the risk of damage to the roots of the cuspid teeth and lower incisors and mandibular nerve. It gives little spongious bone, and it is impossible to provide the harvesting at the same time with the preparation of pocket.

The dissection of the tissue used for the construction of the pyramidal pocket must be very accurate. A sort of “water proof” or better “blood proof” pocket is required to avoid bone contamination from the oral and/or nasal cavity. The previously mentioned principle is for the graft taking and for correct oral-nasal fistula for getting a good functional and aesthetic result.

Since 1981, our protocol for alveolar cleft repair has been applied to 468 patients; it has provided late autologous bone grafting performed at an age ranging between 7 and 11 years. The autologous bone seems to be a good choice because it contributes toward a rapid revascularization, has a high rate of taking, is implanted quickly within the native tissues, allows the eruption of cuspid teeth in a good environment, and is able to be the fixture of dental implants. The spongious bone leads to a more rapid healing of the defect compared with the cortical bone.

The 3 mentioned locations of harvesting, iliac crest, skull, and chin, are good alternatives to choose according to the special clinical evaluation of the patient, size of the cleft, age of the patient, and quality of the bone preferred. There are no differences between the various anatomical areas of the harvesting, as was demonstrated by an experimental study that we did. grafting patients with bilateral cleft. Two bone grafts of different origins, one taken from the iliac crest and one from the skull, were transplanted in the same patient. The experimental results confirm, also with histologic examination, that the harvesting area does not substantially affect the quality of the graft (Figs. 7A, B).

We believe that the variability of outcome has to be searched in the meticulousness and quality of surgery. In the preparation of the pyramidal pocket that will secure the autologous bone, the priority is making hermetic closure “blood proof.”

In our patients, there were no highlight to negative effects on facial growth, providing the bone graft, occurred at this age. In addition, the migration and eruption of cuspid teeth through the bone graft were deemed satisfactory. Even psychosocial aspects during school are manageable.

The correction of alveolar cleft eliminates a deformity of the soft parts determined by the hypoplasia of affected side and lays the fundamental basis for proper rhinoplasty.

Since the time that we started to use the described technique (1981), the results have been so good; even when checked more than 20 years later, we did not feel it necessary to use new methodology that, while providing some benefits, did not seem so radically improved.

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