21 Alveolar Bone Graft

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Key Points

- Six reasons for performing alveolar bone graft (ABG):
  1. Facilitate canine and lateral incisor tooth eruption
  2. Stabilize the alveolar arch to prevent collapse and anterior crossbite and to restore physiologic continuity of the dental arch
  3. Provide bony foundation for the nasal base and ala
  4. Close the nasal floor, including vestibular or oronasal fistula if present
  5. Provide bone stock to enable maxillary advancement to correct midface retrusion as well as support dental implants if needed
  6. Allow for proper orthodontic alignment of the teeth
- Secondary bone grafting using cancellous bone from the iliac crest in the age of mixed dentition (7–9 years) is the gold standard of treatment.
- Orthodontic-surgical joint planning is optimal, and generally the maxilla is widened transversely with a palatal expander shortly before bone grafting.
- Autologous graft is reliable. Recombinant human bone morphogenic protein-2 (BMP-2) with potential use of a demineralized bone matrix carrier may be used to reduce donor site morbidity with early evidence of similar graft outcomes.

Introduction

The alveolus or alveolar bone is the tooth-bearing portion of the maxilla (upper jaw). In a complete cleft of the lip and palate, the alveolus is generally clefted as well (Fig. 21.1). There are five potential consequences of an unrepaired bony cleft: (1) lack of canine and/or lateral incisor tooth eruption, (2) discontinuity of the alveolar arch leading to collapse of the segments and maxillary crossbite, (3) inadequate bony support of the overlying nasal ala and lip causing nasal base asymmetry, (4) persistence of a nasolabial fistula and regurgitation or speech incompetence, and (5) unstable maxilla that cannot be repositioned in orthognathic surgery (Fig. 21.2). Alveolar bone grafting (ABG) is performed to facilitate canine and lateral incisor tooth eruption, stabilize the alveolar arch to prevent collapse and anterior crossbite, provide bony foundation for the nasal base and ala, close the nasal floor, and provide bone stock to enable maxillary advancement to correct midface retrusion as well as support dental implants if needed.

Patient Selection and Clinical Planning

Timing of Surgery

To comprehend better the various ideologies concerning the timing of the alveolar cleft grafting, one first should have a firm grasp of its classification:

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Fig. 21.1 Left unilateral alveolar cleft

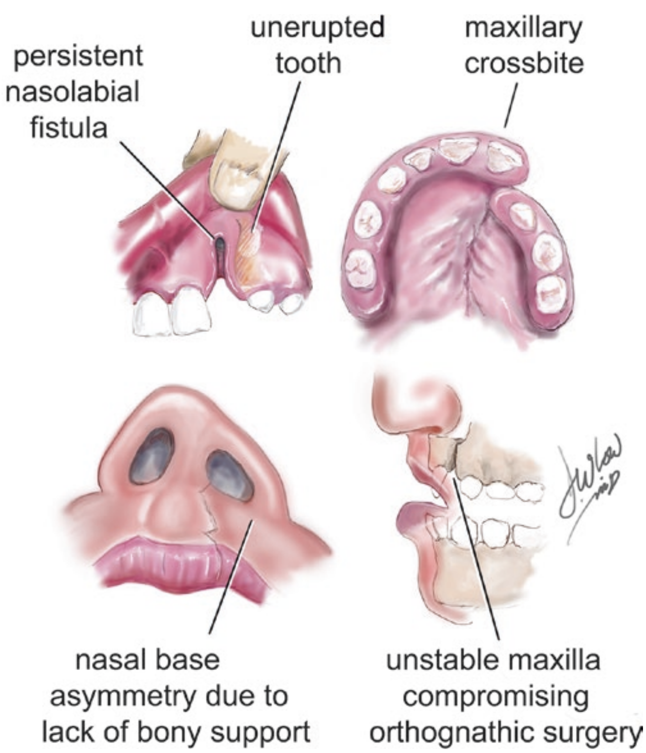


Fig. 21.2 The consequences of an unrepaired alveolar cleft

- Primary (0–2.5 years, usually at the time of lip repair)
- Early secondary (2–5 years, before the eruption of permanent incisors)
- Secondary (6–13 years, before the eruption of the permanent canines)
- Late (>13 years, after the eruption of the permanent canines)

Secondary Bone Grafting

Alveolar grafts, like all bone, require mechanical stimulation to avoid resorption. Timing the bone graft to the natural eruption of permanent teeth into the graft provides this stimulation, as do orthodontic dental movements. Grafting at time of mixed dentition (7–9 years of age, but up to 6–11 years in some patients) coincides with this mechanical stimulation and avoids consequences of impaired midfacial growth from surgery and associated scarring prior to that time.

A panoramic radiograph is typically obtained to visualize the alveolar cleft preoperatively (Fig. 21.3). This can also be used to evaluate the eruption of the canine crown to verify canine descent [7].

A joint orthodontic-surgical plan is essential, in order to correct premorbid maxillary segmental collapse and crossbite through the grafting process. An appropriately widened maxilla has increased transverse diameter to match the lower dental arch, with rounded alignment of the two or three alveolar segments. Preoperative orthodontic preparation is usually preferred, because the alveolar segments have increased mobility for manipulation prior to locking them together with graft. However, disadvantages of presurgical expansion can include widening of the alveolar cleft to a size that makes gingival flap closure difficult. This is particularly of concern for patients with a large existing oronasal fistula; in this patient group, postoperative arch expansion may be advisable at least in part. This is further discussed in Chap. 23.

Additional considerations must be taken into account for older patients (12+). First, while some benefits of bone grafting are still available and even critical (stabilizing the maxilla in advance of orthognathic surgery, providing continuity and stability of the maxillary arch, achieving oronasal fistula closure, for instance), spontaneous eruption of canine or lateral incisor teeth is no longer possible. Second, the bony maxilla tends not to be amenable to expansion by a palatal expander to correct arch collapse much above this age. Thus, a surgically assisted rapid palatal expansion (SARPE) is generally performed, in which a maxillary osteotomy immediately precedes the expansion. Other benefits may be to provide nasal support and placement of dental implants if necessary.

Displaced primary teeth adjacent to the graft site can be extracted at the time of bone grafting in most cases, but if there is concern for maintaining a viable mucosal cuff, these can be extracted 3–6 weeks prior to ABG.

Gingivoperiosteoplasty (GPP)

Gingivoperiosteoplasty (GPP) can be performed during primary lip repair. Flaps of gingival and periosteal tissue

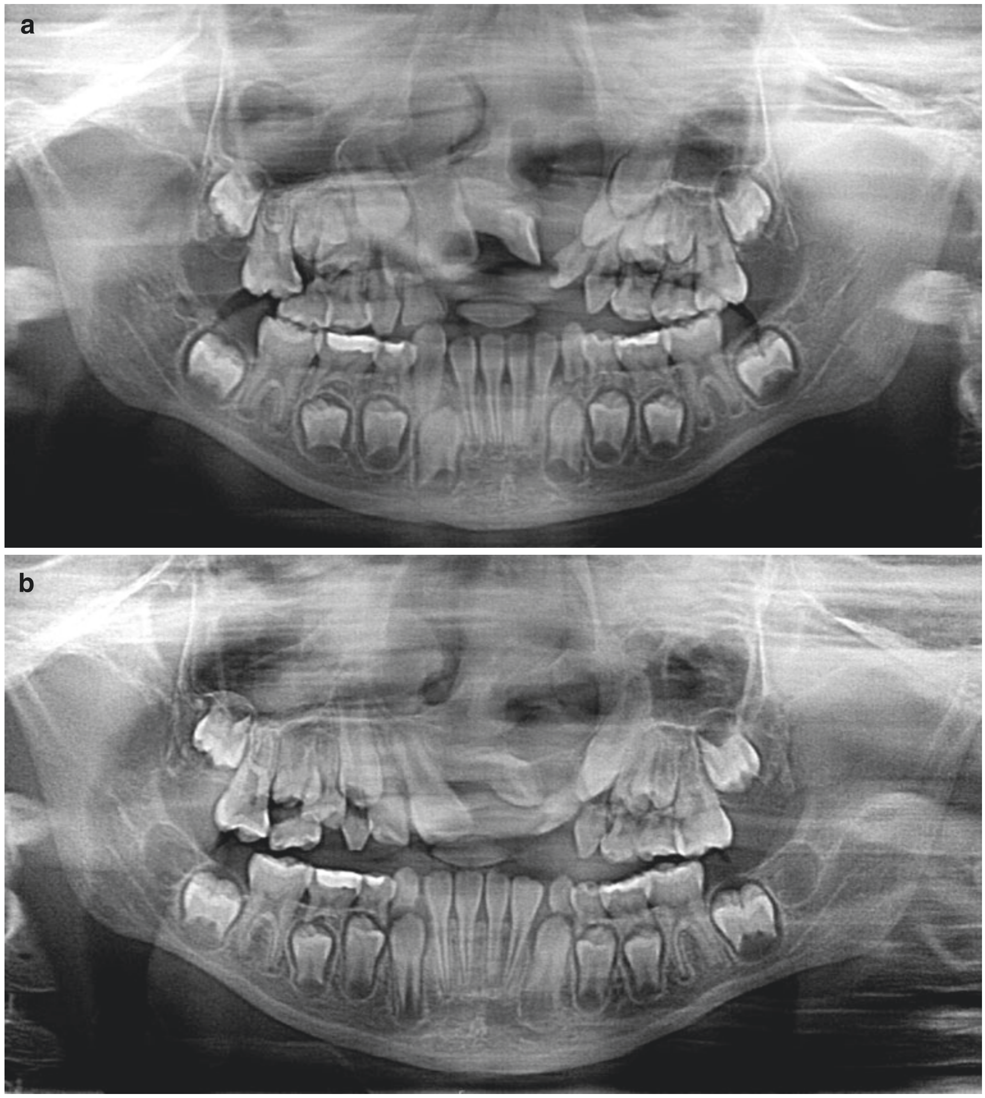


Fig. 21.3 Panorex of a 6-year-old patient with left alveolar cleft, prior to (**a**) and following (**b**) bone graft

are dissected from facing alveolar cleft borders and used to construct "roof, floor, and walls" that can generate bone across a small gap. Modest success rates (50–70%) are reported but only when Latham appliance or nasoalveolar molding (NAM) is used adjunctively to narrow the alveolar gap to approximately 2 mm at the time of GPP [4, 5]. No negative effects on facial growth have been reported. In our experience it is quite rare to encounter patients with well-aligned alveolar segments separated by only a 2 mm gap in low-resource settings. The likelihood of successful bone formation over a larger gap is small. Primary bone grafting in infancy (for example with rib graft) is not shown to be effective and major has donor site morbidity [1–3].

Grafting Material and Donor Sites

Autologous Bone Graft

Autologous bone has been the conventional graft substrate, and historical use of cortical iliac/rib bone blocks has given way to cancellous bone with its superior integration, incorporation, and facilitation of tooth eruption [8]. Cancellous bone is rapidly revascularized over 3 weeks, unlike cortical bone which maintains volume by creeping substitution.

Published success rates of autologous ABG are typically 80–90% [6]. A canine can be expected to erupt in all patients though in a minority may erupt palatally rather than on the dental arch, and approximately half will show lateral incisor eruption.

Donor Site Selection

The iliac crest is generally preferred, due to its high density of bone marrow and endochondral cancellous bone volume [9]. Its location permits a two-team approach of simultaneous graft harvest during alveolar site preparation, which minimizes anesthetic and operative time. The primary drawback is postoperative pain, although newer modalities improve its management (see Anesthesia). Long-term donor site disability or deformity is rare, and minimizing muscle and periosteal dissection reduces these consequences. Reapproximating the cartilage cap may minimize anterior iliac contour irregularity. Cranial bone graft, although described, is primarily cortical bone [10].

Bone Graft Substitutes

An off-the-shelf grafting substitute to autologous bone could eliminate the pain and scar of donor graft sites, the added operative and anesthetic time, small risk of donor site disability, and heterogeneity and limited volume of graft material. Recombinant human bone morphogenetic protein-2 (rhBMP-2) was approved by the FDA for maxillofacial use in 2007 and is the best studied substitute to date [12]. Many teams use cadaveric demineralized bone matrix (DMB), which consists of organic collagen, as a three-dimensional "carrier" of the liquid BMP. Early data suggest similar dental eruption and stability, but further insight into clinical and dental outcomes is needed [11, 13]. The complication profile also appears similar, with consistently increased rates of transient alveolar edema but without greater dehiscence rates. Although associated with shorter operating room (OR) time and inpatient stays, at a material cost of $300–3000 per patient, rhBMP/DMB is not yet cost-effective in most low-resource settings. Finally, although early- to short-term mitogenic risks of carcinoma do not appear formidable in the growing facial skeleton, parents need to be advised of this risk.

Operative Staging of Fistulas and Bilateral Clefts

In cases of larger nasolabial or oronasal fistula or less experienced surgeons, it is often preferable to perform a staged approach with first fistula closure (see Chap. 20) followed by alveolar cleft graft. If both are done in combination and a watertight closure is not achieved or too much tissue tension is present, risk of fistula recurrence and loss of graft is high.

Unilateral alveolar clefts are grafted in a single stage. Bilateral alveolar clefts introduce two particular concerns: volume of defect and perfusion of premaxillary tissue. The volume of cancellous bone graft required to fill a bilateral alveolar defect may exceed what is readily available in the iliac wing of the appropriately aged patient. Thus, the surgeon may need to consider harvesting from the contralateral hip or consider staging the procedure. Typically, following a 6-month interval, abundant cancellous bone has regenerated in the original site which can be reharvested. Additionally, single-stage bilateral alveolar cleft reconstruction creates additional challenge in sufficiently mobilizing gingival mucosal flaps, while limiting premaxillary dissection and consequent risk to blood supply. Therefore, most surgeons perform two-staged reconstruction of bilateral alveolar clefts with an interval 6-month period.

Operative Planning

Radiographic Evaluation

A preoperative panoramic X-ray (panorex) is important to assess the extent of bony bridging, which can be difficult to clinically assess beneath the mucosa (Fig. 21.3). A cone beam 3D CT offers higher-fidelity bone image, where available (Fig. 21.4). Other radiographic evaluation may include occlusal and periapical films of the cleft region for a more detailed evaluation.

Orthodontic Expansion

Preoperative orthodontic preparation is usually necessary to expand the anterior maxillary crossbite, due to inward collapse of the mobile alveolar segments, and to align the anterior teeth. This process often takes at least 4 weeks and may utilize a palatal expander such as a Hyrax to gradually widen the anterior palate to restore appropriate maxillary width (see Chap. 23). This preoperative expansion is important because an ABG "locks in" the palatal segments into fixed position.

Relevant Anatomy

The three-dimensional alveolar cleft is best thought of as the shape of a tornado or a pyramid placed upside down on its point. Viewed frontally (coronal plane), the width of the cleft is greater at the piriform margin of the alveolus (superior) than the dental margin (inferiorly) (Fig. 21.5). A more critical visualization is laterally (sagittal plane), again showing a much larger defect superiorly, where the alveolus tends to have considerable posterior projection, than inferiorly.

Incisional design depends on whether a nasolabial or oronasal fistula is present. In either case, attached alveolar gingiva, which lines the alveolar process portion of the cleft, must be maintained in proximity to the anticipated site of dental eruption to ensure viability of adult teeth. When the

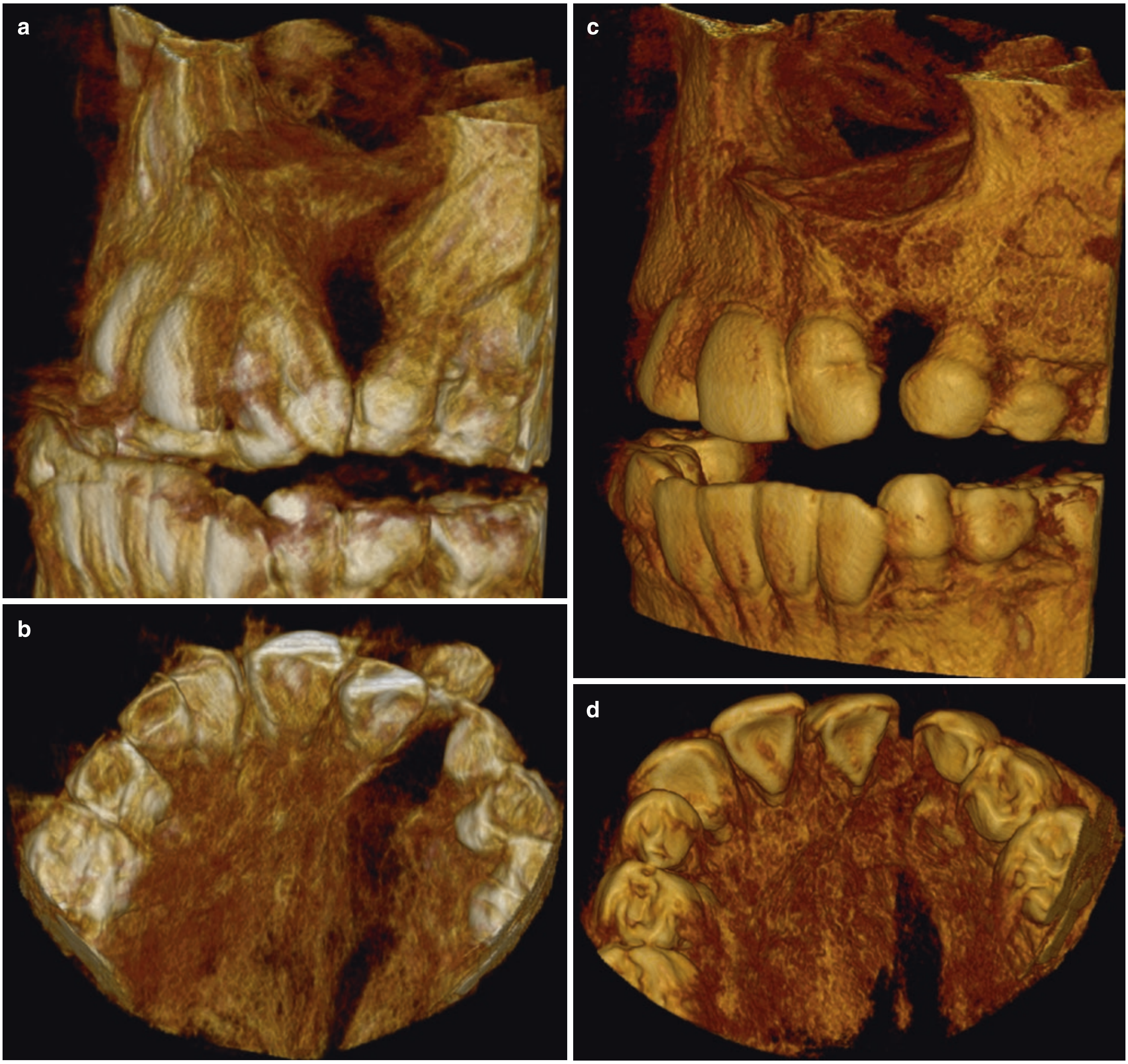


Fig. 21.4 Cone beam 3D CT scan of a 6-year-old patient with left alveolar cleft, prior to (**a**, **b**) and following (**c**, **d**) repair

nasal floor has been appropriately repaired at time of lip repair, and a fistula is not present, incisions are typically designed parallel to the incisors through the gingival mucosa. The incision is typically positioned anteriorly of the midsagittal plane, preserving more tissue to transpose posteriorly, because additional anterior gingiva can be transposed through lateral dissection, release, and advance to a greater degree than posterior gingiva.

In the presence of a fistula, simultaneous closure of multiple tissue layers must be planned, in addition to the gingival reconstruction of the alveolus, the nasal floor-alveolar interface, as well as the oral roof-alveolar interface (Fig. 21.6). The nasal floor is generally best closed with the use of a vomer flap raised in the subperichondrial plane medially and a lateral nasal wall flap raised in the subperiosteal plane laterally. The oral roof, which is the posterior extension of the alveolar gingiva into the palate, can generally be closed with subperiosteal dissection over the bony palatal shelves and medial tissue rotation with a lateral back cut as needed.

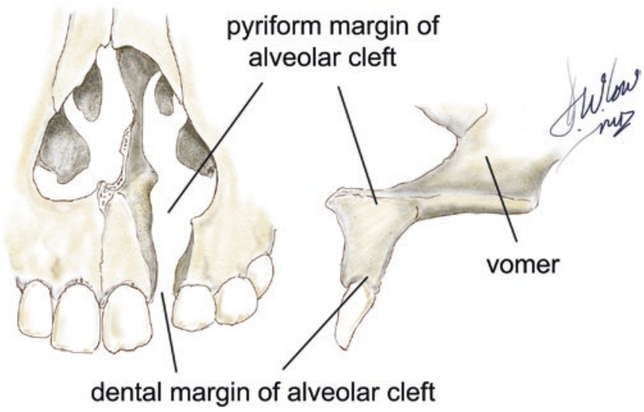


Fig. 21.5 Coronal and sagittal views of the 3D alveolar cleft deformity, resembling a "tornado"

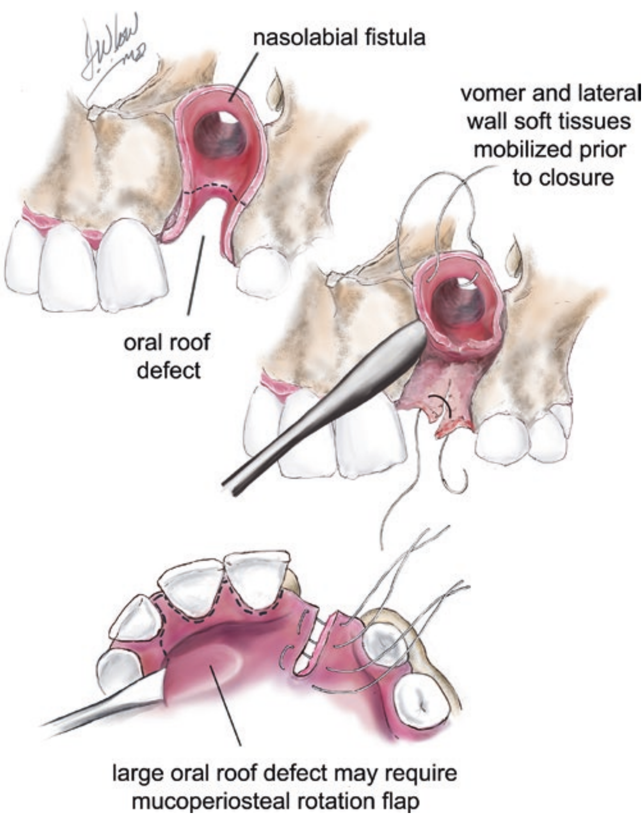


Fig. 21.6 Incisions and closure pattern of a nasolabial fistula at time of alveolar bone grafting

Failure to completely close all mucosal surfaces over the bone graft will result in salivary contamination and graft resorption. Repeat of the procedure is then necessary and often more difficult due to the presence of scars.

Fig. 21.7 Helpful instruments for alveolar bone graft. (**a**) "Plastic smile" lip retractor, (**b**) Weitlaner self-retaining retractor for iliac exposure, (**c**) Freer and (**d**) Molt #9 periosteal elevators, (**e**) bone tamp, (**f**) McElroy-type curettes, (**g**) trephine for percutaneous graft harvest

Key Equipment (Fig. 21.7)

Mouth Field

- Plastic "smile" lip retractor allows the surgeon to operate, while an assistant harvests bone graft.
- Several elevators – Freer, Molt #9 periosteal dental, Woodson, and angled pharyngoplastic dental – can each be helpful for subperiosteal gingival cuff elevation.
- A bone tamp enables solid graft packing.
- 4-0 and 5-0 Vicryl suture on tapered needle for mucosal closure.

Hip Field

- A Weitlaner sharp self-retaining retractor allows one surgeon to harvest graft while the assistant prepares the recipient site.
- An Obwegeser periosteal elevator facilitates elevation of the cartilaginous cap.
- McElroy-type curettes, especially 8–12 mm cup diameter, are the mainstay of cancellous bone harvest.
- Alexander-type gouges, 8–12 mm diameter, are also helpful for harvesting bone.
- A trephine, such as the Spine-Tech grinding harvester, can be used for percutaneous graft harvest.
- 2-0, 3-0, and 4-0 Vicryl suture for muscular, superficial fascia, and dermal reapproximation; 4-0 Monocryl subcuticular closure.

Splint

A stabilization dental splint provides two functions postoperatively. First, it stabilizes the alveolar segments, preventing collapse and assuring rigidity to enable bony healing. This is particularly important in a bilateral cleft, in which the mobile premaxillary would otherwise prevent graft take. Second, it provides mechanical protection to the healing mucosa. This can be fabricated from acrylic by an orthodontist preoperatively and bonded at time of surgery. Alternatively, it can be made intraoperatively (see Field Hack box).

Field Hack: Intraoperative Splint Fabrication

A postoperative acrylic dental splint can be fabricated in the operating room by the surgeon. The acrylic polymer powder is mixed 1:1 with liquid monomer on the back table to make a cylinder 12 cm in length and 1 cm in diameter. This is molded to the maxillary dentition, bringing mandibular dentition into occlusion and then removing the excess with a high-speed burr.

Anesthesia

General orotracheal anesthesia is employed during surgery. Locoregional anesthesia is an important adjunct, particularly for the hip donor site which causes the majority of postoperative pain.

Hip Donor Site

Transverse Abdominis Plane (TAP) Block

Injection of long-acting local anesthesia in the plane between the internal oblique and transversus abdominis muscles of the lateral abdomen blocks the intercostal nerves (T7–12) and iliohypogastric nerve (T12-L1) that provide sensation of the iliac crest region [14]. This offers superior pain control and shorter length of stay than field anesthesia or systemic narcotics and is similar to a long-acting analgesia infusion catheter [15]. An 18 gauge needle is inserted into the ipsilateral inferior lumbar triangle, which is bordered by the iliac crest inferiorly, latissimus dorsi muscle posteriorly, the external oblique muscle anteriorly, and the costal margin superiorly (Fig. 21.8). This can be performed with a blunted needle using the "double pop" technique – representing the needle traversing the fascial extensions of the external oblique followed by internal oblique muscles. Bupivacaine (0.4 mL/kg of 0.5% or 0.8 mL/kg of 0.25%) is infiltrated; this reserves 20% of maximal local anesthesia dose to be used in the alveolar region. If available, ultrasound guidance enables visualization of this plane as well as appropriate hydrodissection with infiltration (Fig. 21.9).

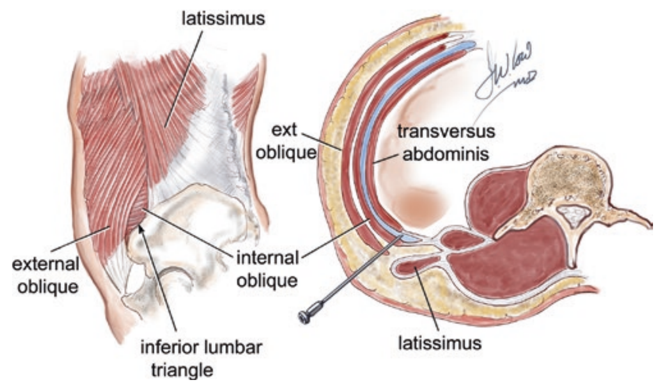


Fig. 21.8 Inferior lumbar triangle formed by the iliac crest, latissimus dorsi, and external oblique muscles which is accessed for a posterior transverse abdominis plane (TAP) block

Bupivacaine-Soaked Sponge

Alternatively, an absorbable gelatin sponge (Gelfoam) can be infiltrated with bupivacaine and placed inside the iliac crest harvest site prior to closing the cartilage cap. Additional dose can be infiltrated as a field block. Again, a dose of 0.4 mL/kg of 0.5% or 0.8 mL/kg of 0.25% is used, reserving 20% of maximal local anesthesia dose to be used in the alveolar region.

Alveolar Recipient Site

Bilateral infraorbital nerve blocks are placed and partially reduce innervation to the superior dental plexus. Superior alveolar nerve branches are not addressed by the infraorbital nerve block and are best addressed with field infiltration (ordinarily a mixture of lidocaine, bupivacaine, and epinephrine; for instance, equal parts lidocaine 1% with epinephrine 1:100,000 and bupivacaine 0.25%). This should include the alveolar cleft, anterior palate, nasal floor, and lateral gingival tissue to be advanced.

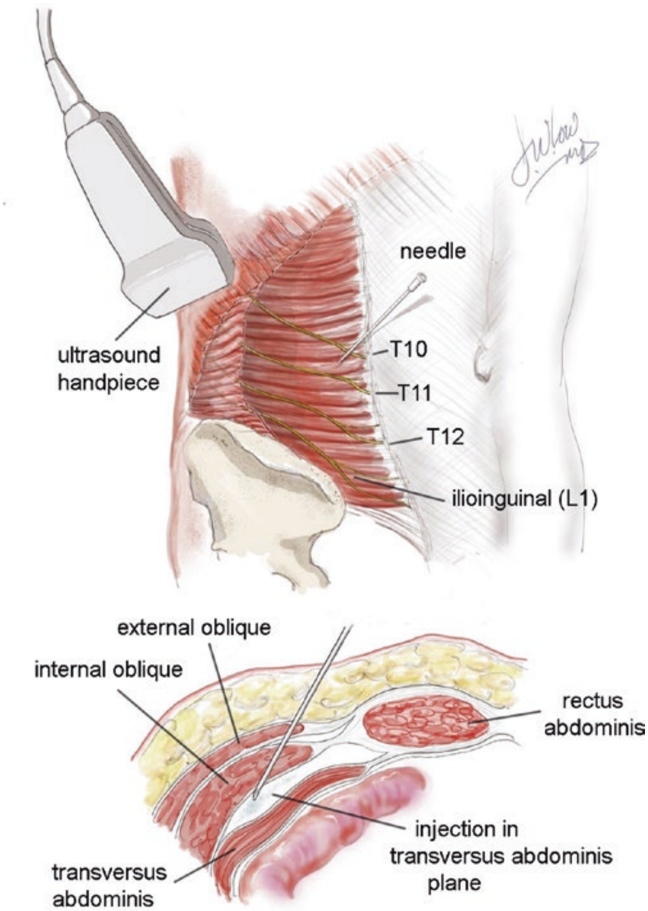


Fig. 21.9 Transverse abdominis plane (TAP) block. Ultrasound can give visual guidance and the "double pop" technique through the fascial extensions of the external followed by internal oblique muscles to give palpable guidance, to correct positioning in the transversus abdominis plane. Here showing an anterior approach

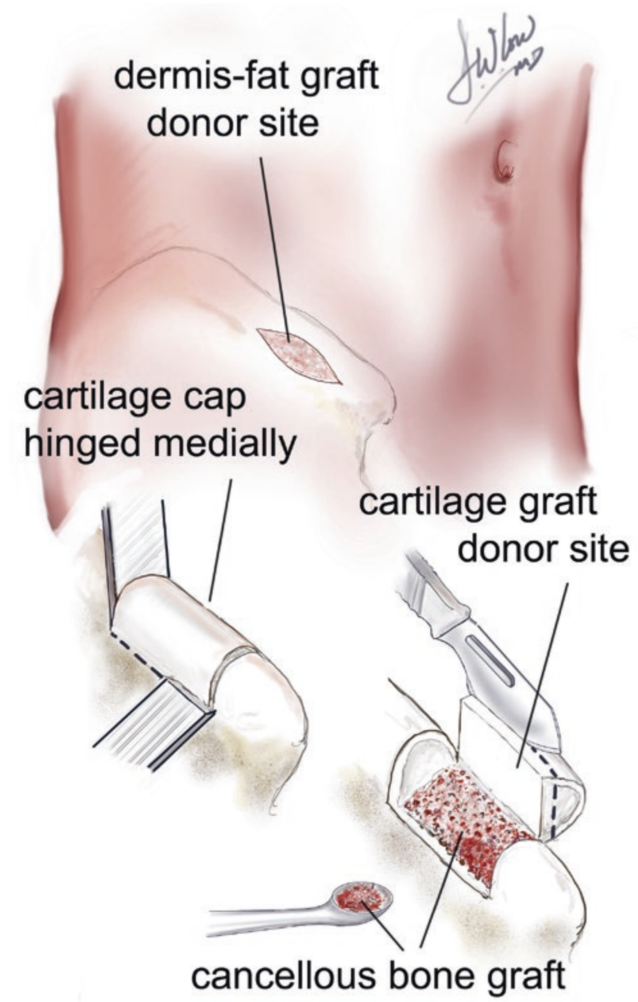


Fig. 21.10 The anterior superior iliac crest is exposed, and the cartilage cap is hinged medially, to access cancellous bone for graft harvest. Placing the iliac crest incision 2 cm lateral to the anterior iliac prominence reduces visibility of scar and avoids the lateral femoral cutaneous nerve. Soft tissues are retracted medially during bone graft harvest. The anterior superior iliac crest incision can also be used for harvesting an elliptical dermis-fat graft

Procedural Technique

Separate sterile fields and instruments are used at the hip donor site and mouth, to prevent cross contamination of oral flora to the clean hip. When possible, use a two-team approach for simultaneous graft harvest during recipient preparation.

Iliac Crest Graft Harvest

A 30-degree bump is placed under the hip, and a 3-cm-long incision is designed parallel to and 2 cm lateral to the anterior superior iliac crest (ASIC) (Fig. 21.10) [16]. This incision design both hides the scar in the shadow lateral to the iliac crest prominence and prevents iatrogenic damage to the more medial lateral femoral cutaneous nerve [6]. The non-dominant hand is used to place traction over the soft tissue to align the incision directly over the ASIC, and subcutaneous tissue and muscle fascia are incised down to the cartilage cap, and the Weitlaner retractor is inserted. Wide access can be facilitated through a small incision by sliding the soft tissue superiorly and inferiorly along the ASIC. A "treasure chest" pattern is incised with a scalpel through the cartilage cap, leaving the cap "hinged" medially like the lid of a treasure chest (Fig. 21.10).

This exposes the trilaminar iliac crest, with cortical bone medially and laterally and cancellous bone centrally. Cancellous bone is then harvested with a curette or gouge, with care to avoid including the cortical bone or cartilage. Volume needed is determined by recipient defect, generally 4–6 cc for a unilateral cleft. A cortical bone graft can be harvested from the lateral crest if needed for stability but will have less osteoinductive attributes. Following harvest, the cartilage cap is replaced anatomically to prevent hip contour irregularity and overlying tissue closed in three layers.

Alveolar Cleft

After a throat pack is placed, the mouth and nose are cleaned thoroughly with chlorhexidine rinse to decrease bacterial load. In a technique similar to that first reported by Abyholm [9], incisions are designed along the medial and lateral alveolar cleft gingiva (Fig. 21.11a). The incision is carried up superiorly at the transition point from buccal to palatal mucosa, taking care to aim toward the lip and not the nasal floor. Next, medial and lateral mucoperiosteal flaps are designed with the incision through interdental papillae to enable anterior gingival closure. In a bilateral cleft, the entirety of mobilization must be done from the lesser segment (laterally); this is also generally our practice in unilateral clefts. The lesser segment flap is raised in a subperiosteal plane, with lateral periosteal release to enable medial transposition.

Additionally, the periosteum can be scored horizontally 2 cm above the inferior border to enable unfurling inferomedially. Sufficient mobilization allows the gingival flap to be shifted one tooth width toward the cleft. Medially, the gingival tissue is raised approximately 1 cm in width to enable cleft exposure and flap inset.

Posterior gingival flaps are then elevated in the subperiosteal plane, which are contiguous with palatal mucosa posteriorly (Fig. 21.11b). Ample elevation is critical in this posterior space, as the bone deficit is primarily posteriorly. A rasp can be used gently along the cortical bone surface staying superficial to prevent tooth root exposure, which may facilitate graft take. Finally, dissection proceeds superiorly toward the nasal floor. If a fistula is not present, wide dissection creates space beneath the intact nasal floor to enable graft positioning and can be performed with scissors or needle-point electrocautery. If a fistula is present, subperichondrial dissection of a vomer flap is performed medially, and subperiosteal dissection of lateral nasal wall flap is performed inferior to the inferior turbinate laterally. In bilateral clefts, a V-shaped fistula between the premaxilla and palatal mucosa is often encountered. An angled scalpel blade is helpful to incise horizontally at the nasal-oral mucosal junction, with ample submucosal elevation to enable closure of the nasal mucosa and oral mucosa as separate layers. Endpoint of dissection is reached once there is sufficient graft space, corresponding to the inverted pyramid shape up to the level of the piriformis, with volume of approximately 4–6 cm^3.

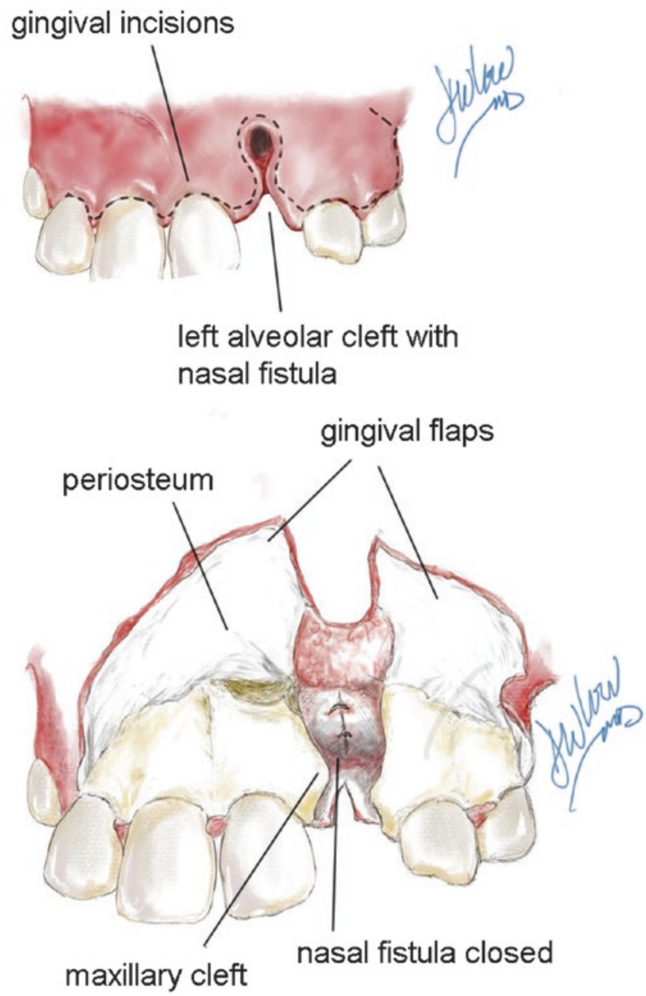


Fig. 21.11 Marginal incisions along the alveolar cleft gingiva are extended up into the buccal mucosa, as is a vertical lateral releasing incision (**a**, upper). After elevating anterior gingival flaps, subperiosteal dissection is carried posteriorly to create a space for graft behind the alveolar bone, followed by closure of the nasal mucosa (**b**, lower)

Closure is then performed of the nasal floor and mobilized fistula tissue as needed, using 4-0 or 5-0 Vicryl suture (Fig. 21.11b). The posterior gingival flaps are then approximated in everted fashion to close the oral mucosa. Generally, inserting a Dingman mouth gag and placing these sutures and tying knots down on the palatal surface are advantageous. Cancellous graft is brought from the clean (hip) to contaminated (mouth) field and any large pieces or morselized with a rongeur to ease packing (Fig. 21.12). Pressure is placed sequentially as each piece is added using a tamp or Freer elevator to ensure tight packing. A cortical fragment (strut) can be placed on the roof of the defect prior to placement of cancellous bone; however, we find that this does not necessarily facilitate better bone take and can increase risk of extrusion. Careful attention is paid to the placement of early

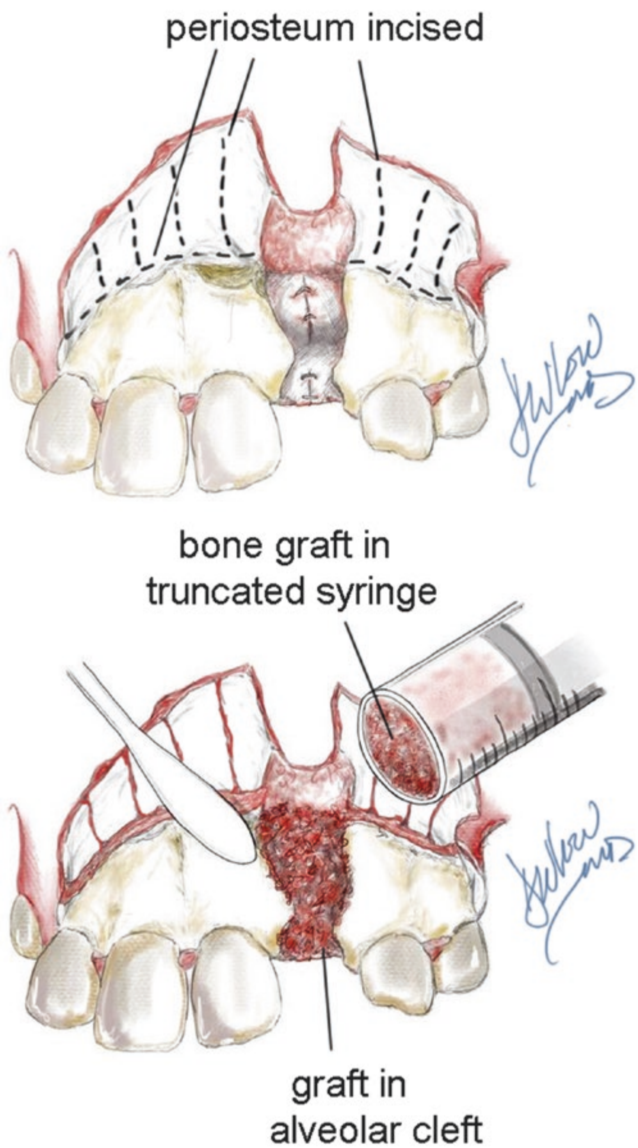


Fig. 21.12 Cancellous bone graft delivered into alveolar cleft. Scoring of the periosteum in multiple planes enables expansion of gingivoperiosteal flaps to cover graft with minimal tension

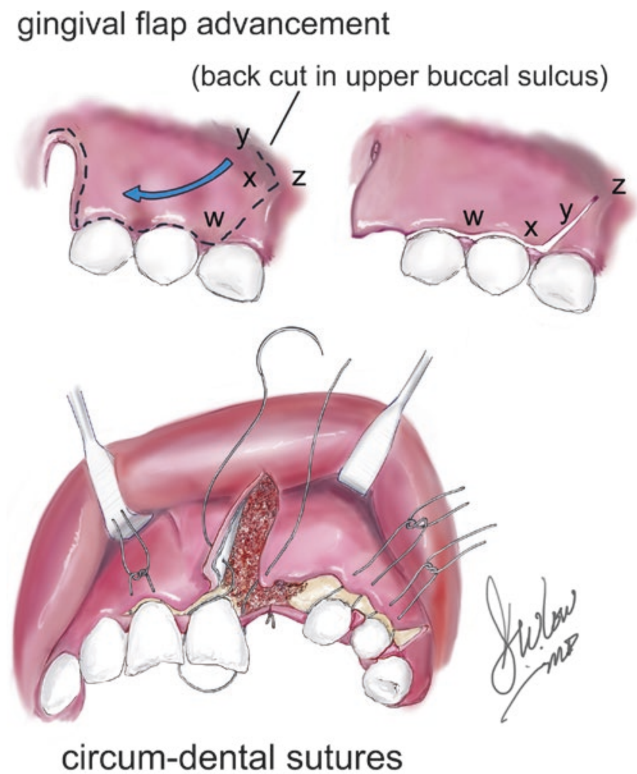


Fig. 21.13 Gingival flaps are rotated and advanced toward the alveolar cleft, which is facilitated by a back cut. Circum-dental sutures provide secure, watertight approximation of the advanced flap

graft pieces superoposteriorly to fill beneath the nasal floor and behind the alveolar segments bilaterally to ensure tooth root support. The anterior gingival flaps are closed in interrupted fashion, thus medializing the lateral gingival-periosteal flap (Figs. 21.13 and 21.14). The flap is also secured along the dental margin using interrupted or circum-dental sutures. Finally, the dental splint is placed and secured. It can be bonded using dental adhesive or wired to the teeth or brackets and is usually kept in place for 6 weeks.

Tips and Tricks: Alveolar Bone Graft

- Inserting a Dingman mouth gag to enable suture placement and tie down on the palatal surface often facilitates a more robust closure.
- After the nasal layer closure, injecting saline into the nostril with a 10 cc syringe can ensure a watertight closure with no leaks.
- Horizontal scoring of the maxillary periosteum is critical to enable the flap to be advanced inferiorly and medially advanced without tension. Vertical scoring of the maxillary periosteum may also be helpful for medial mobilization of the advancement flap.
- Good hygiene is essential – preoperative chlorhexidine mouth cleanse, postoperative antibiotics, and separate instrumentation for the donor site – to preserve graft viability and prevent cross contamination.

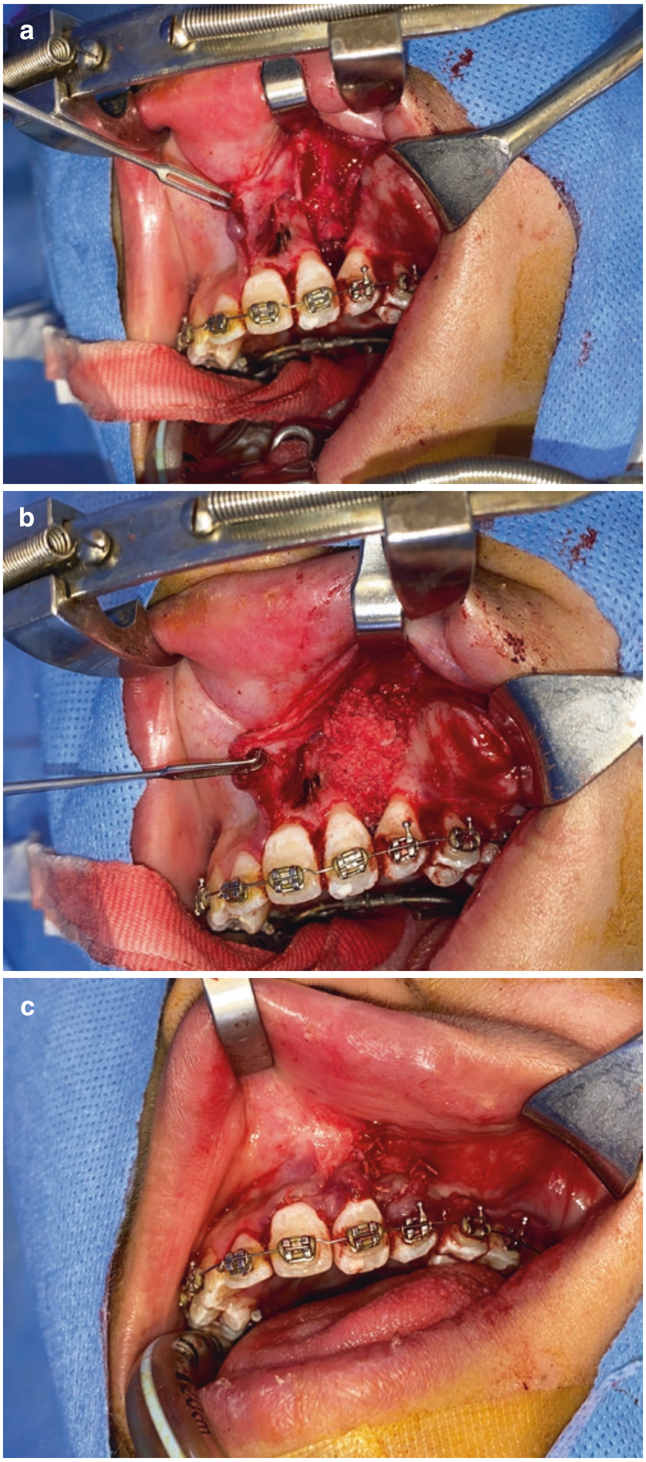


Fig. 21.14 Subperiosteal exposure of a left alveolar cleft (**a**), completion of cancellous bone grafting (**b**), and gingival flap closure (**c**). V to Y mucosal advancement flap combined with the dermis-fat graft provides additional bulk and mucosa to correct upper lip deficiency

Simultaneous Tip Rhinoplasty and Lip Augmentation

Iliac crest bone grafting provides the opportunity to harvest cartilage and dermis-fat grafts from the same donor site to be used for tip rhinoplasty and lip augmentation. For lip augmentation, an ellipse can be superficially incised and de-epithelialized just below the iliac crest to provide a suitable dermis-fat graft to correct a volume deficiency such as a whistle deformity along the vermilion margin. For minor deficiencies, a vertical incision in the vermilion provides enough exposure to create a submucosal pocket. The graft can be stabilized with absorbable sutures at the corners. For larger deficiencies, a V to Y mucosal advancement flap combined with the dermis-fat graft provides additional bulk and mucosa to correct the deficiency (Fig. 21.15).

In the unilateral cleft, augmentation of the typically hypoplastic lower lateral crus with a thin iliac crest cartilage graft can provide useful support after centralizing the alar domes with permanent monofilament suture. Excision of a crescent of skin along the alar rim with a small transverse extension in the columella provides adequate exposure, and complete and meticulous dissection of the lateral crus permits easy splicing to the cartilage graft and mobilizes the alar web. The shape of the crescent is created using a template of the contralateral alar rim (Fig. 21.15). The most challenging part of the dissection is separation of the surprisingly adherent intranasal skin from the cartilage. A block of cartilage can be harvested from the cartilage cap for augmentation of the deficient ala in a unilateral cleft (Figs. 21.16 and 21.17). Extending the length of the lateral crus helps to prevent recurrent collapse of the tip and helps to support the external nasal valve. Chromic quilting sutures help to stabilize the intranasal skin and prevent recurrent webbing after placement of the cartilage graft in the pocket.

Iliac cartilage can also be used for a columella strut graft in a bilateral cleft nasal deformity. The graft can be placed in a precise pocket using either the lip scar, if one is also revising the cleft lip scars, or through the upper buccal sulcus after raising the premaxillary gingiva flap. Long-lasting but absorbable monofilament mattress sutures can be placed through the skin, medial crura, and cartilage graft to stabilize the columella construct.

Follow-Up and Complication Management

Overnight admission for pain control is typical; same-day discharge may be considered when a TAP block, trephine harvest, or bone graft substitute is used. There are no hip

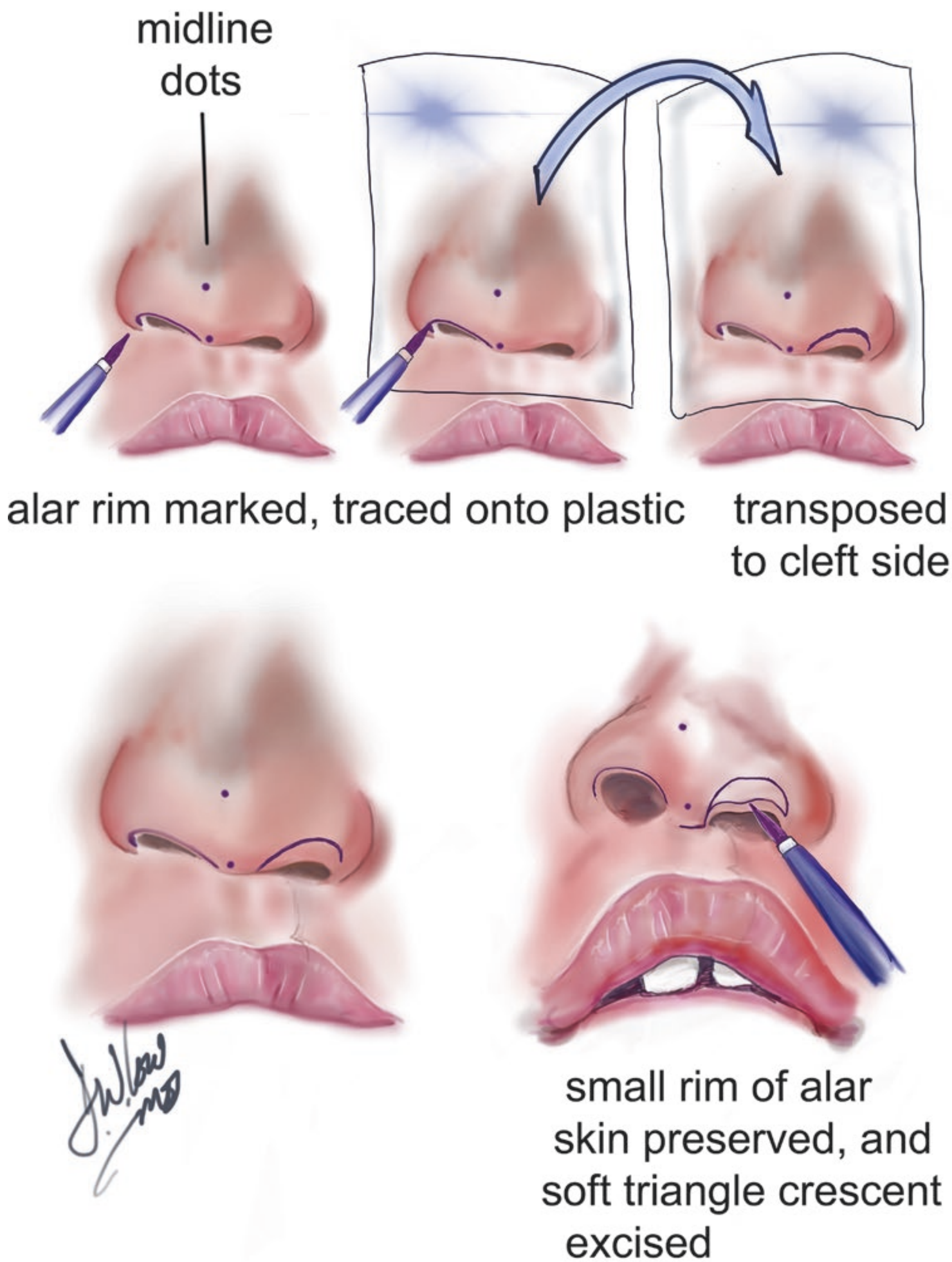
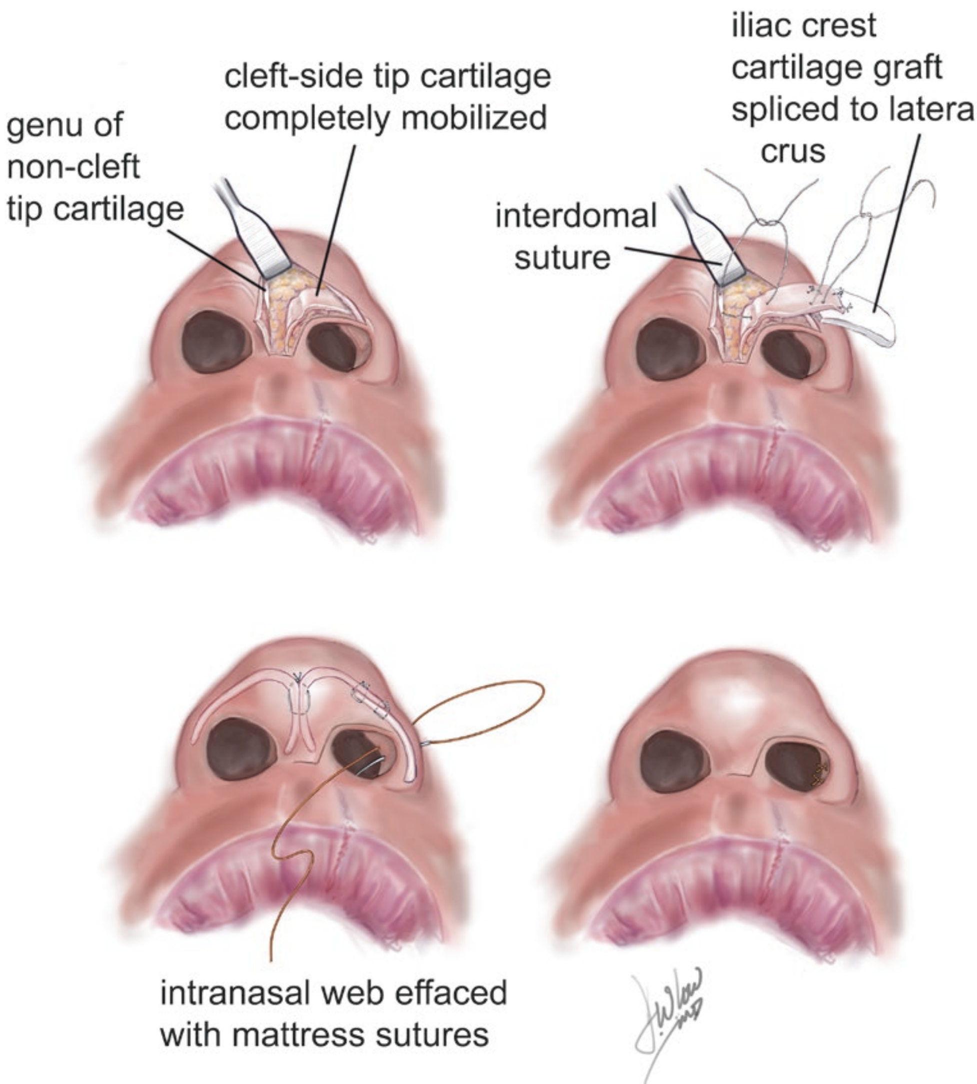


Fig. 21.15 Template guidance for excising a crescent of alar rim skin to provide exposure and address soft triangle collapse

donor site precautions or ambulation limitations. Postoperative antibiotic prophylaxis is employed (oral amoxicillin-clavulanic acid, 7–14 days) to prevent graft infection and resorption, although there is little evidence to guide antibiotic selection or duration. Parental education on the importance of pureed ("soft" or "no chew") diet for 6 weeks and oral hygiene is essential and aided by three times daily chlorhexidine or saline mouthwash. Elixir non-steroidal anti-inflammatory agents (e.g., ibuprofen) and/or acetaminophen for 4–7 days are issued for pain control.

A panoramic radiograph is repeated 6 months postoperatively to assess for bony calcification across the alveolar cleft. The most common complication is graft resorption, which requires repeat grafting in approximately 10% of cases, and is typically associated with partial mucosal incisional dehiscence. Dehiscence and partial graft exposure can sometimes be salvaged by debriding the exposed piece(s) of cancellous graft.



Figs. 21.16 and 21.17 Tip rhinoplasty at time of alveolar bone graft utilizing iliac cartilage graft

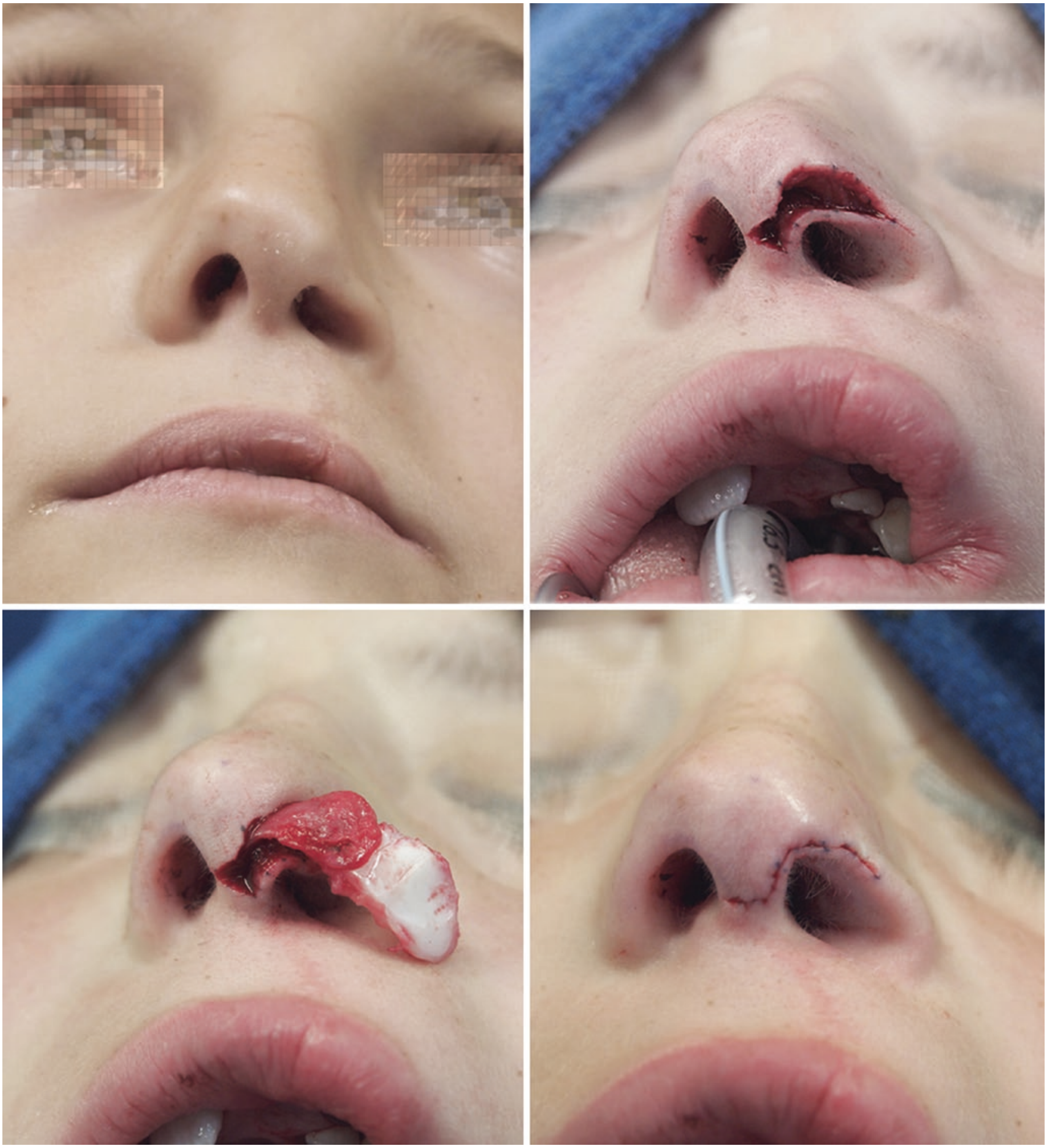


Fig. 21.16 (continued)

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Alveolar Bone Grafts, Case 1

Case Study: Extruded Premaxilla in an 8-Year-Old Male with Bilateral Cleft Lip/Palate

Vilma Arteaga and Edwar Alvarez

Case Analysis

This 8-year-old boy with bilateral cleft lip, palate, and alveolus has undergone previous lip and palate repair, but his premaxilla is anteriorly and inferiorly displaced. His posterior maxillary segments are collapsed and he has small nasolabial fistulas in line with the unrepaired alveolar segments, and a small anterior palatal fistula near the incisive foramen. He is entering age of mixed dentition, although retains primary dentition.

Goals of care are to level his premaxilla with his maxillary arch, create an arch with bony contiguity and appropriate width, and achieve mucosal patency.

Treatment Considerations

When orthodontic care is available, planning should be made jointly by orthodontist and surgeon and begins with obtaining orthopantogram X-ray (OPG). This patient's dental age appears delayed, and OPG is not likely to yet show canine root development. Orthodontic preparation can involve: (1) elevation of premaxilla (for instance, using Plana's tracks; 6–12 month process), (2) transverse maxillary expansion (hyrax, hass, or quad-helix expanders; 1–3 months), (3) gradual repositioning of premaxilla into middle third space created after expansion, or (4) use of a myofunctional appliance (made from acrylic or prefabricated device, such as Myobrace). Following orthodontic repositioning, alveolar bone grafting can be performed. Given the fistula presence, bone grafting is likely to be more durable if each side is grafted in staged procedures. A small fistula can be closed at the time of bone graft placement; however, larger fistulas are better closed in a staged fashion 6 months prior to bone grafting.

When orthodontic care is not available, consideration could be made for a surgical premaxillary setback (see Chap. 23). However, in this case, because of the collapsed posterior maxillary segments, there is no space in which to reposition the premaxilla. Thus it would not be beneficial.

Alveolar Bone Grafts, Case 2

Case Study: Extruded Premaxilla in a 4-Year-Old Male with Bilateral Cleft Lip/Palate

Edwar Alvarez and David Alvarez

Case Analysis

This young boy with bilateral cleft lip, palate, and alveolus has undergone previous lip and palate repair, but his premaxilla is more severely exposed with anterior and inferior displacement. The upper lip rests behind the premaxilla, retracting it away from the alveolar arc.

Goals of care are to level his premaxilla with his maxillary arch, create an arch with bony contiguity and appropriate width, and achieve mucosal patency.

Treatment Considerations

This patient is too young for orthodontic manipulation or bone grafting, and given the gap between his alveolar segments, options could include a premaxillary setback or sulcoplasty.

In this case, a sulcoplasty was performed with T-shaped division of the premaxillary gingiva, advancement of the gingivobuccal mucosa, and relocation of the lip to recreate a sulcus. This has improved the premaxillary-upper lip relation, which with time may enable the band-like effect of the orbicularis oris muscle to retract the premaxilla into the alveolar arc.