SECONDARY ALVEOLAR BONE GRAFTING

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GSR Institute of Facial Plastic Surgery

- Non-profit hospital established in 1996
- Dedicated Cleft & Craniofacial Centre of Excellence
- Presently 1,600 cleft and cranio-facial surgeries are done every year
- 4 surgeons and 6 fellows with full support team
- More than 4 0,000 documented cleft & craniofacial surgeries have been performed since 1996
- 600 primary new born cleft children are registered every year

The Past

- The first reported case of bone grafting to the alveolus is by Von Eiselberg - he used pedicled osteocutaneous flap to cover the palatal defect

- The first successful bone graft to an alveolar defect was by Drachter in 1914 - he utilized tibial bone graft with periosteum.

The Era of "Early Bone Grafting" - Primary bone grafting

In 1962 a group of surgeons and orthodontists proposed "early bone grafting"

- The authors believed that - the alveolar cleft was a bridge between the retruded cleft side and growth promoting septum on the non cleft side

- The early bridging of alveolus would allow for normal growth of cleft side

- This approach of "early bone grafting" continued throughout 1970s

Coots BK. Alveolar bone grafting: past, present, and new horizons. Semin Plast Surg. 2012 Nov;26(4):178-83.

The Present

- Since 1964 many publications have been suggesting that grafting at this early stage causes serious growth disturbances of the middle third of the facial skeleton.

- Though very few centers still perform early bone grafting it's a has been abandoned in most centers dealing with cleft lip and palate

- Secondary bone grafting, meaning bone grafting in the mixed dentition, became an established procedure after abandoning primary bone grafting.

A follow-up study of cleft children treated with primary bone grafting. 1. Orthodontic aspects.*Friede H, Johanson B*
Scand J Plast Reconstr Surg. 1974; 8(1-2):88-103.

Rationale and Indications for SABG

- Allowing tooth eruption through grafted bone
- Stabilization of maxillary arch, improving the condition for prosthodontic treatment such as crown, bridges and implants
- Providing bony support for orthodontic closure of teeth in cleft region
- Speech problems caused by escape of air from oronasal communication can also be improved
- It can also be used to augment the alar base to achieve symmetry with non-cleft side, thereby improving facial appearance

Graft Sources

Cortical Bone

- Cortical bone takes a longer time to incorporate as it relies upon vascular ingrowth by creeping substitution
- A cortical graft will usually be replaced by invasion of bone cells originating from the recipient site.
- The metabolic turnover and remodeling of cortical bone are much slower than in cancellous bone.
- Remains as component of new and necrotic bone
- More susceptible to infection

Cancellous Bone

- Cancellous bone is more vascular, has more space, contains more bone regeneration and has better ingrowth of new bone from the adjacent bone segments.
- The cancellous autografts heal primarily by osteogenesis – Osteo-conduction and Osteo-induction
- The cancellous grafts are also found to better enable tooth eruption
- It is completely replaced by new bone and provides greater mechanical strength

Iliac Crest

- Iliac bone is the most commonly used bone in bone grafting
- It provides a large amount of cancellous bone
- 2 surgeon approach is taken and the cleft side can be prepared at the same time as that of harvesting

•No growth disturbances

Disadvantages

- Possible scarring
- Transient post operative pain
- Delayed ambulation and mild transient gait disturbances

To reduce complication

- Make limited incision
- Minimal musculature elevation
- Meticulous haemostasis
- Re-approximation of cartilage cap
- Adequate pain control with early ambulation

Trephine technique should be employed to harvest maximum cancellous bone to avoid complication

Ilankovan V, Stronczek M, Telfer M, et al. A prospective study of trephined bone grafts of the tibial shaft and iliac crest. Br J Oral Maxillofac Surg 1998;36:434-9.

Cortico cancellous bone graft from iliac crest

Cranium

- Advantage of a concealed scar
- Less post operative pain
- Less resorption

Disadvantage

- Sparse cancellous bone
- Increased operative time
- Increased risk of post operative complication – dura exposure

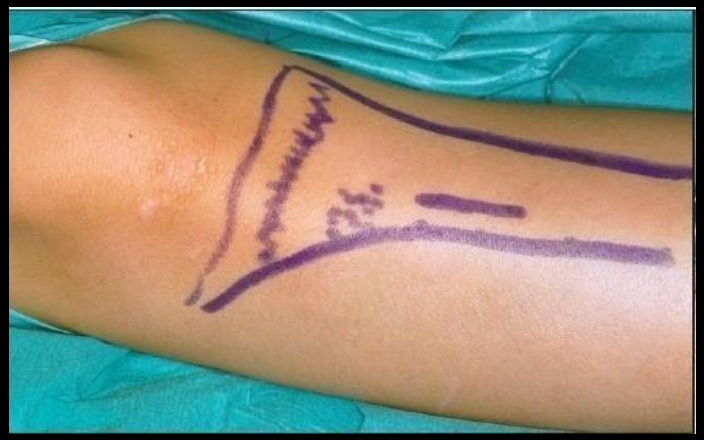
Dural tear, CSF leak, hematoma,

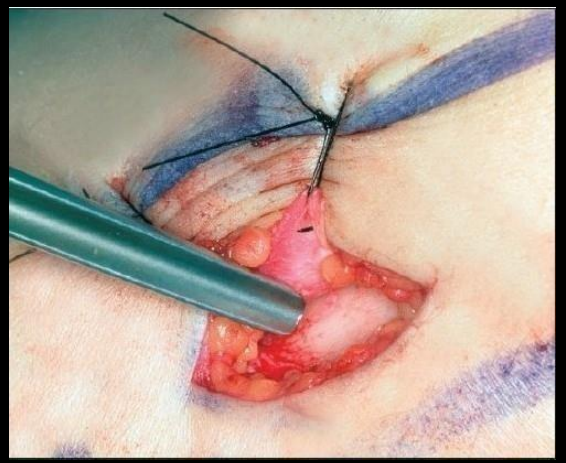
Tibia

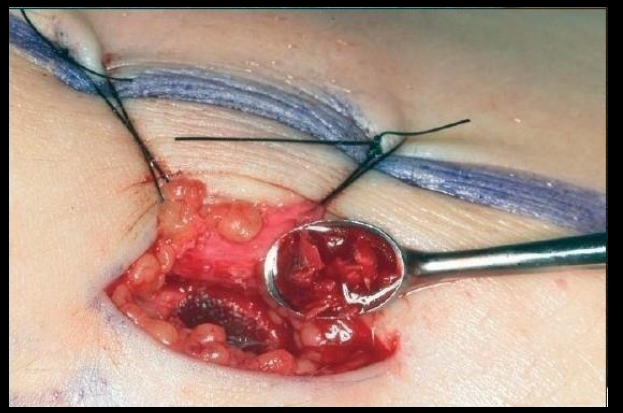
- The use of tibia results in less - bleeding, post operative time, post operative pain and also allows early ambulation

Disadvantages

- Possible growth disturbances because of injury to epiphyseal plate growth centre
- Less quantity of cancellous bone as compared to Iliac rest so the other leg tibia is often used







Source - Internet

Mandibular Symphysis

- The mandible has same embryonic origin as that of maxilla
- Because it's a membranous bone, the resorption is low and revascularization is fast
- Surgery can be performed in the same operative field and thus discomfort is less with lesser hospital stay
- Disadvantages
- The amount of bone that can be collected depends on the mandibular development
- Risk of mental nerve, central and lateral incisors roots damage

RIB

- Rib has also been utilized to close the alveolar cleft; however, it is considered to be of limited use by many due to its donor site morbidities, including visible scarring and pain.

- Rib grafts have also been criticized for difficulties in orthodontic tooth movement

Kuijpers-Jagtman AM, Stoelinga PJ. Letters to the editor. Cleft Palate Craniofacial Online Journal 2000;37:421

The Future?

- Because of the donor site morbidity and complications associated, there are many ongoing efforts to find alternate source for graft material

BMP

- One of these sources is bone morphogenic protein (BMP) delivered on a collagen sponge
- Reports have shown some success with the application of this product.
- It is important to note that this product has substantial cost and for some its availability is limited thereby increasing the "burden of care"

Fallucco MA, Carstens MH. Primary reconstruction of alveolar clefts using recombinant human bone morphogenic protein-2: clinical and radiographic outcomes. J Craniofac Surg 2009;20 (Suppl 2):1759–1764 Seminars

DBFB and FDB

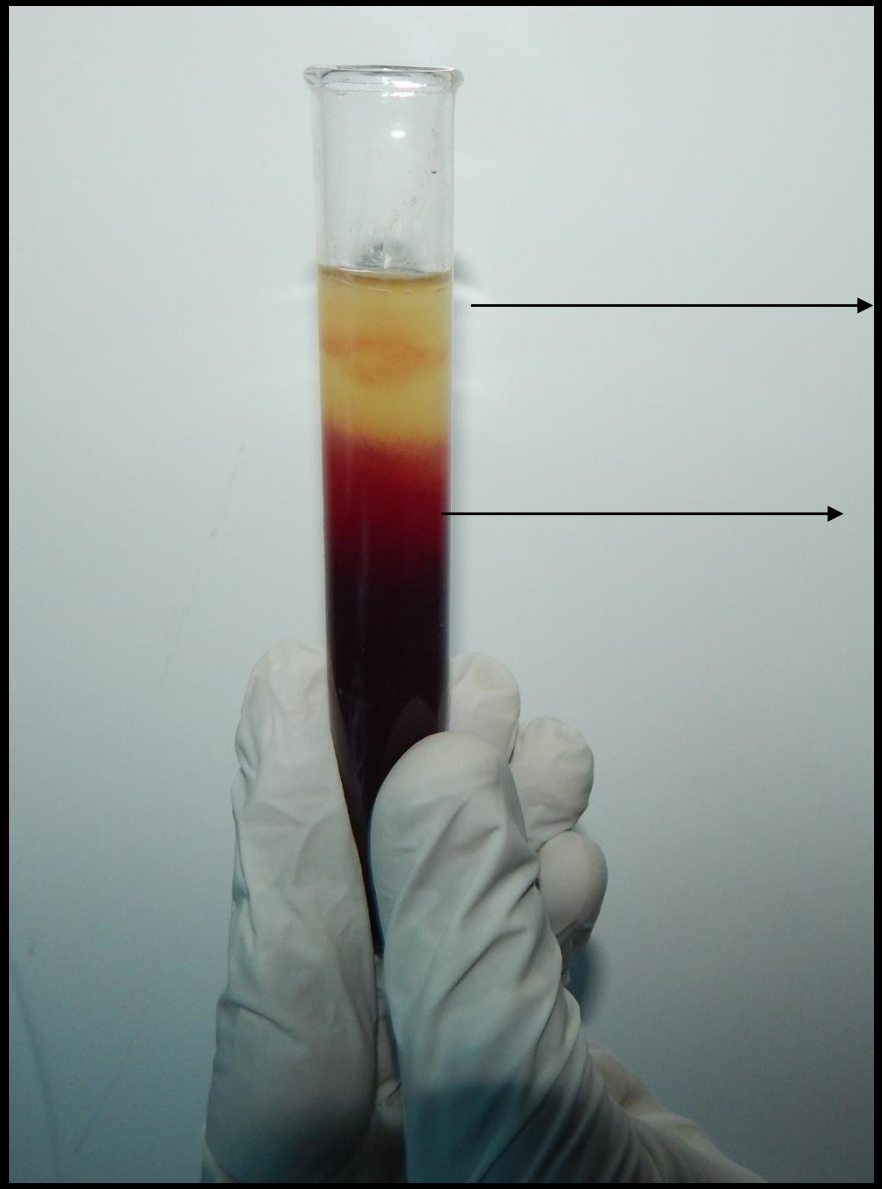
- DFDB (demineralized freeze - dried bone) and FDB (freeze - dried bone) posess a high osteoconductive property.

- Francis et al. compared the results in various ways and suggested the possibility of substituting an iliac bone graft for a bone graft by adding recombinant human bone morphogenetic protein rh BMP to the DBM scaffold.

- These substitutes have the advantage of reducing donor-site morbidities, infection, disease transmission, and host incompatibility have been reported

- In animal studies, premature fusion and growth restriction of the suture line have been reported

PRP and PRF



PLATELET RICH PLASMA (PRP)

PLATELET RICH FIBRIN (PRF)

Recently addition of PRP and PRF to the graft bone have been put into practice but its usefulness is still questionable and more research is warranted for the same.

β-TCP

- Microstructured Beta Tri calcium Phosphate has also being used as a substitute to autologous bone grafts.

- Jenssen NH et al reported that - Secondary alveolar grafting using microporous β-TCP can safely be used in the clinical situation.

- Residual calcified tissue, canine eruption, and complication rates at the recipient site are comparable to those with autologous grafts.

Janssen NG, Schreurs R, de Ruiter AP, Sylvester-Jensen HC, Blindheim G, Meijer GJ, Koole R, Vindenes H. Microstructured beta-tricalcium phosphatefor alveolar cleft repair: a two-centre study. Int J Oral Maxillofac Surg. 2019 Jun;48(6):708-711. doi: 10.1016/j.ijom.2018.11.009

rhBMP-2

- Literature review shows of all the bio-materials Recombinant human bone morphogenic protein-2 (rhBMP-2) has been best studied and showed comparable efficacy to iliac crest bone graft in terms of volume of bone regeneration, bone density, and capacity to accommodate tooth eruption within the graft site.

- The balance between innovation and safety is a complex process requiring constant vigilance and evaluation.

- A lot of study and research is still required before we can safely consider replacing autologous bone grafts with bone substitutes and allografts

Alternatives to Autologous Bone Graft in Alveolar Cleft Reconstruction: The State of Alveolar Tissue Engineering. J Craniofac Surg. 2018 May;29(3):584-593.

Although there are a few studies and literature reviews reporting different compatible bio materials to replace autologous bone grafts, there are no systematic reviews and meta analysis done to conclusively suggest the most appropriate biomaterial.

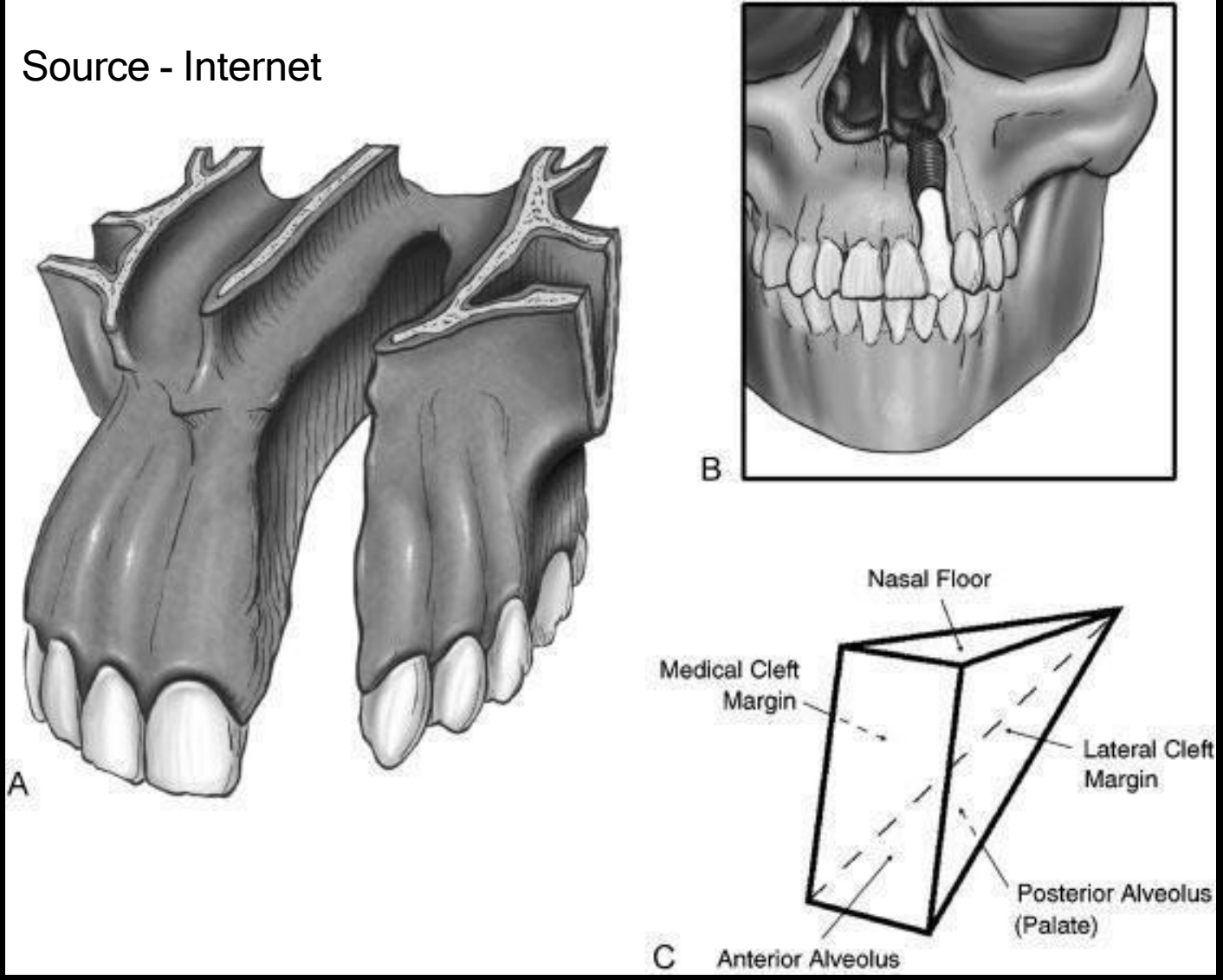
As of now alveolar cleft defect grafting must include autologous bone grafts as none of the current modalities in practice can replace autologous bone graft

Further studies are required to search for idea bone graft substitute.

Our Technique

Morpho-functional Alveolar Bone Grafting

Source - Internet



Morphology of the defect - The defect when viewed in 3 dimensional appears, Triangular or Pyramidal

PATIENT PREPARATION

- After the preoperative work up, the patient is shifted to the operation theatre.
- Intravenous line is established and maintained with RL/ DNS solution.
- Preanesthetic medications are administered intravenously.
- After induction of general anesthesia, orotracheal intubation is done using ‘South Pole RAE tube’ and is secured with 2 strips of dynaplast [first strip should be in an inverted V shape fashion encircling the tube and the second strip is in horizontal direction across the endotracheal tube].
- The dynaplast strips should be firmly adherent to the facial skin on either side.
- General anesthesia is maintained with inhalational anesthetics.

STEPS FOLLOWED AFTER ENDOTRACHEAL INTUBATION

- Make sure that the armamentarium is arranged as per the order.
- Place a hip roll over the side to be operated to make the anterior superior iliac spine **(ASIS)** more prominent.
- Preparation of the surgical area thoroughly with betadine solution [at least 6 inches proximal to the operative site].
- Place the head drape covering both the ears & eyes of the patient.
- Place a towel with hole over the iliac region.

- Place 2 body towels, one over the upper half of the body & the other over the lower half of the body.

- Extend the body towel & secure the head drape as well as the body towel along with the head ring using towel clips on either sides making sure that the towel clips are not injuring the ears.

- Spread the fine tipped bipolar cautery cable & the suction tube & ensure that they are connected to the source.

- Connect the suction tip & the cautery tip & ensure their function.

- Cover the cables with the body towel & secure a towel clip [taking care that the towel clip is not engaging the cable wires/ suction pipe].

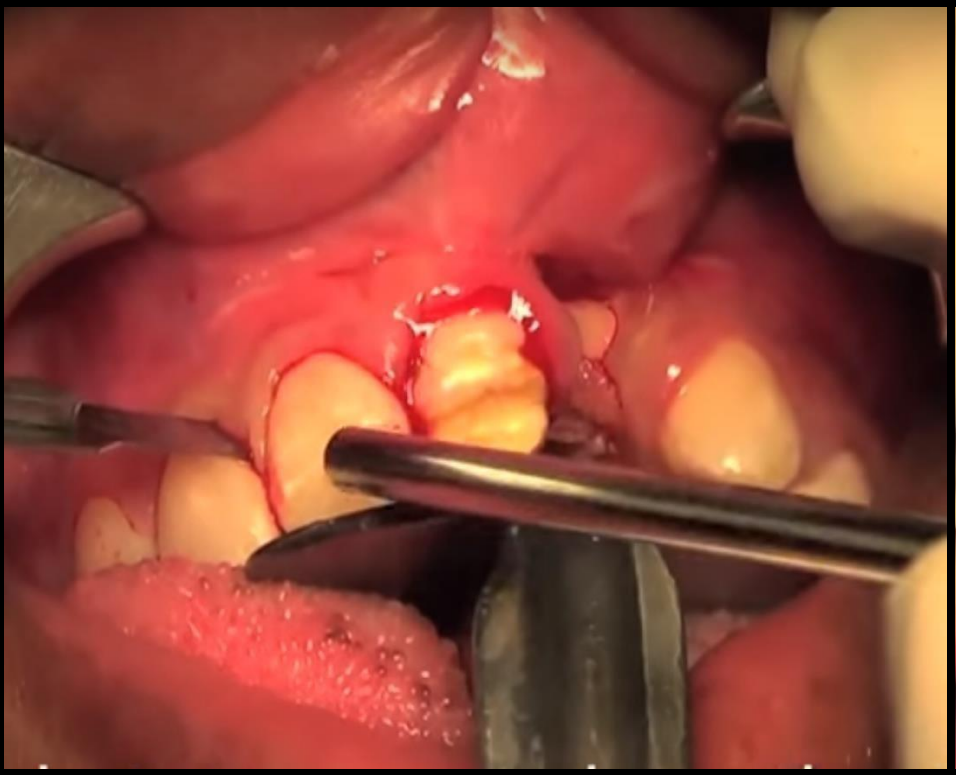
RECIPIENT SITE - SURGICAL INCISION & FLAP DESIGNING

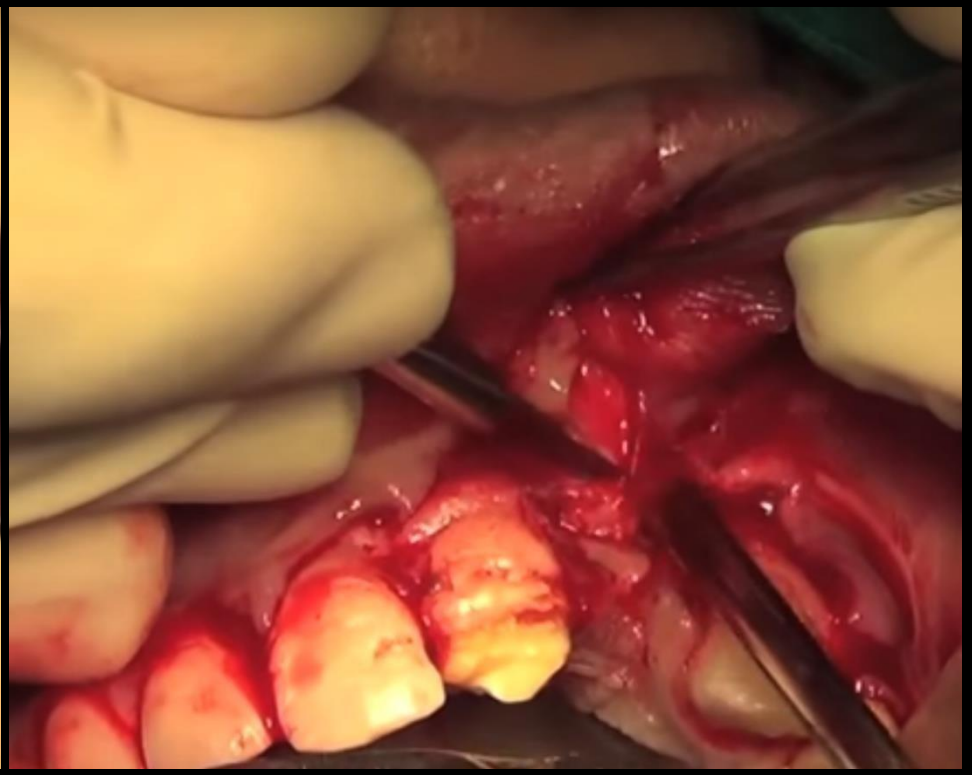
- Local infiltration is done using 2% lignocaine with 1:80000 adrenaline under the supervision of an anesthetist.
- The amount of LA solution to be used is calculated according to body weight of the patient.
- The maximum dose of lignocaine with adrenaline which can be used is 7.0 mg/ Kg body weight of the patient, not to exceed 500 mg.
- Wait for 5 minutes to achieve desired level of vasoconstriction.

- With a no.15 surgical blade a crevicular incision is placed extending from the mesial interdental papilla of 1st molar on the cleft side upto two teeth beyond the defect margin on the non cleft side.

- The incision is continued along the margins of the cleft alveolus & with sharp dissection, the oral layer is separated from the nasal layer.

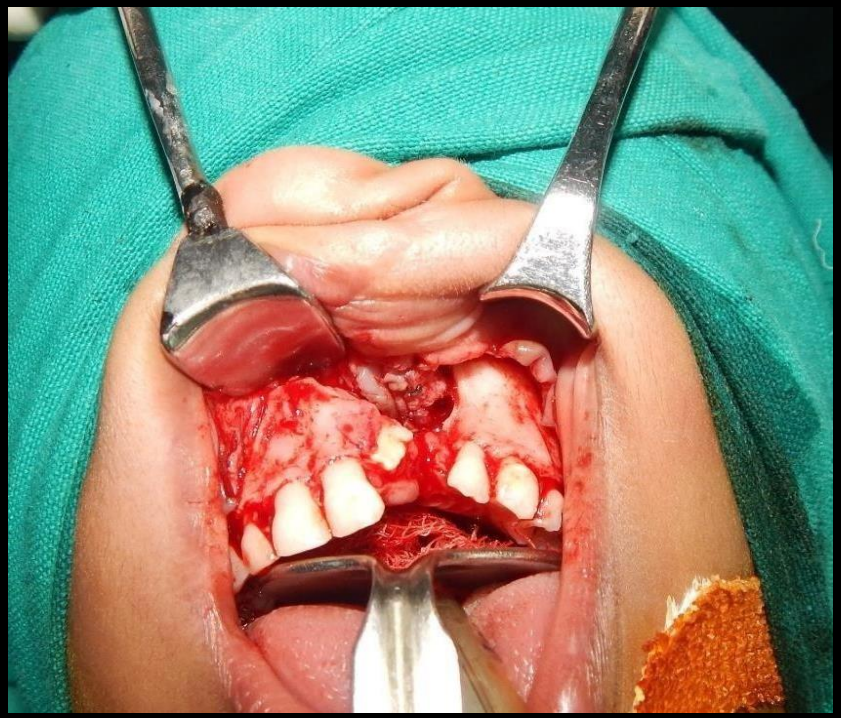
- Perforations if any in the nasal layer are sutured using 4-0 vicryl suture & the nasal layer is used to form a bed to receive the bone graft.





- Crevicular Incision extending around the defect to reflect the mucoperiosteum

- Sharp dissection to separate the nasal layer from oral layer



- Nasal layer is elevated in cephalad direction from palatal floor, and palatal floor is sutured

- Perforations if any, in nasal layer is sutured using 4-0 Vicryl

ANTERIOR ILIAC CREST BONE HARVESTING – PAEDIATRIC GROUP

1. Incision Marking

- **Point 1** is at the highest point of the antero-superior iliac spine **(ASIS)**.
- **Point 2** is approximately 1cm superior to the 1st point.
- **Point 3** is approximately 1cm lateral to the 2nd point.
- **Incision-** A 2cm long incision is marked in a superior direction form point 3 parallel to the anterior iliac crest.

2. Surgical Incision & Dissection

- Local infiltration is done using 2% lignocaine with 1:80000 adrenaline under the supervision of an anesthetist.
- The amount of LA solution to be used is calculated according to body weight of the patient.
- The maximum dose of lignocaine with adrenaline which can be used is 7.0 mg/ Kg body weight of the patient, not to exceed 500 mg.
- Wait for 5 minutes to achieve desired level of vasoconstriction.
- The skin over the iliac spine is retracted medially & local infiltration is done using lignocaine with epinephrine.
- A 2 cm long incision is placed using no. 15 surgical blade in a superior direction form point 3 parallel to the anterior iliac crest.
- The incision is deepened through the skin, subcutaneous layer, fat layer & the scarpa's fascia. The iliacus muscle is identified & is retracted medially to expose the cartilage.

3. Harvesting Marrow-Cancellous Bone- "H- Shaped" incision is designed over the cartilage & is retracted to expose the ilium.

- The vertical limbs of H are across the iliac cartilage and the horizontal limb of H is longitudinally in the middle of the iliac cartilage.
- The anterior vertical limb should be at a distance of 3 cm from the anterior superior iliac spine (ASIS) and the posterior vertical limb can be placed at a variable distance from ASIS depending on the amount of bone to be harvested [maximum permissible distance of 8 cm from ASIS].

- The medial & the lateral cortical plates are identified & the cancellous bone is harvested from within the medial & lateral cortical plates without damaging them using an osteotome & bone gouge.
- Cortical plate when desired is harvested from the medial side.
- The bone chunks are placed on a petridish & covered with blood soaked gauze pieces.
- The bone chunks are crushed into small pieces & platelet rich plasma is simultaneously prepared & in incorporated with the cancellous bone chips.

ANTERIOR ILIAC CREST BONE HARVESTING [ADULTS]

1. Surgical Incision & Dissection- The procedure of iliac harvesting in the adults is essentially similar to that of the pediatric group till the point of soft tissue dissection. After exposure of the anterior iliac crest incision is given over the periosteum and subperiosteal dissection is done to expose the antero superior iliac crest and spine.

2. Harvesting Marrow-Cancellous Bone- Cancellous bone can be harvested by any one of the following techniques:

A. Trap Door Technique

B. Medial Subcrestal Technique

A. Trap Door Technique- In this technique the osteotomy cut is made over the iliac crest starting from a point 3 cm posterior to ASIS and can be extended to a distance 8 cm posterior to the ASIS. The osteotomy cut is deepened to hinge the medial cortex with its muscle and fascial attachment medially so as to expose the marrow-cancellos bone. Cancellous bone can be harvested by trephines or bone gouge.

B. Medial Subcrestal Technique- In this technique after exposure of the iliac crest, iliacus muscle is retracted medially to expose the medial cortical plate. A subcrestal triangular osteotomy is performed on the medial cortex with the base toward as well as parallel to the iliac crest and the base facing caudally. The medial cortex is removed to expose the underlying marrow cancellous bone. Cancellous bone is harvested using bong gouge.

4. Wound Closure & Dressing- The wound is packed with a betadine soaked gauze for 15-20 minutes so as to achieve hemostasis.

After establishing hemostasis, wound closure is performed in layers.

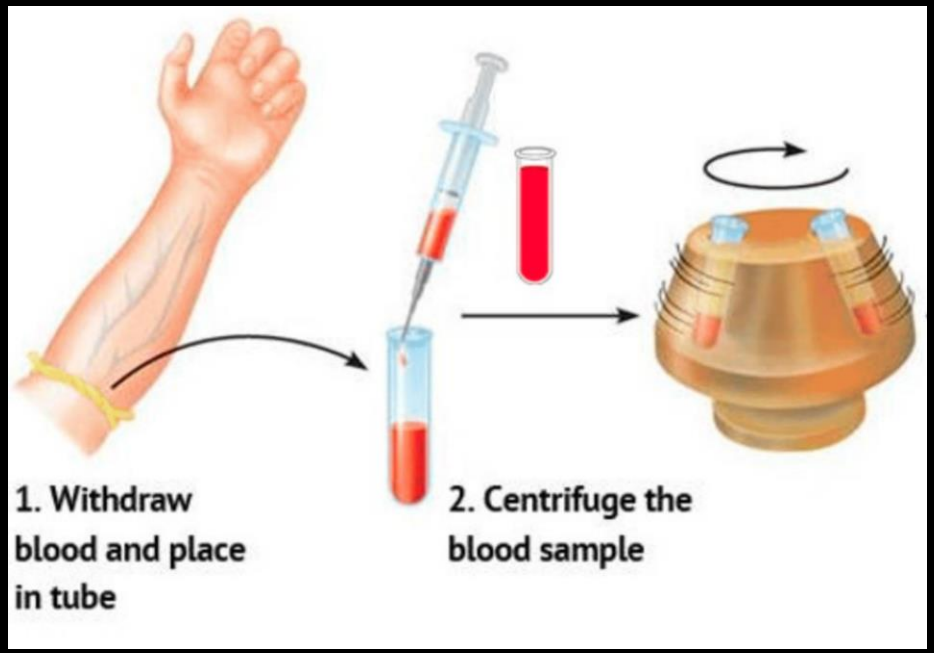
Firstly, the cartilage, followed by the iliacus muscle approximation, scarpa's fascia, & the subcutaneous layer using absorbable sutures (3-0 catgut or 3-0 vicryl suture).

Skin closure is achieved using 3-0 prolene or ethilon suture.

Following the wound closure, 2ml of bupivacaine is infiltrated for postoperative pain relief.

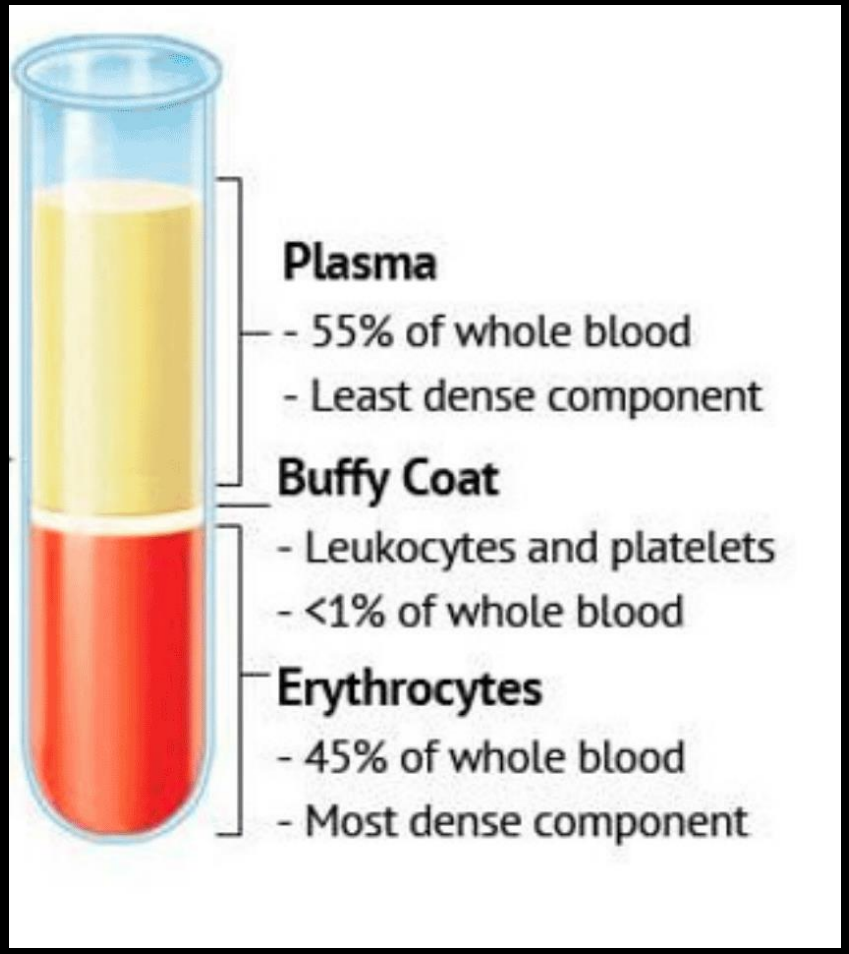
Soframycin based dressing is done followed by dynaplast pressure bandage.

PREPARATION OF PRF

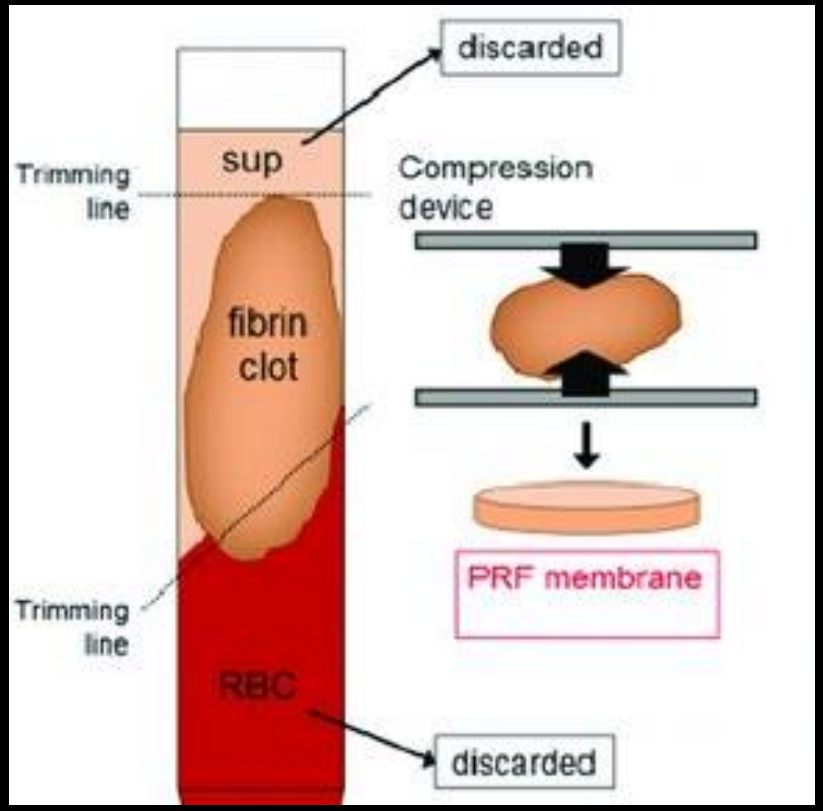


- 10ml of venous blood is collected from the patient and transferred to a glass test tube.
- The sample is then centrifuged at 3000rpm for 12 minutes.

LAYERS OBTAINED AFTER CENTRIFUGATION OF BLOOD



PREPARATION OF PRF MEMBRANE FOR PLACEMENT AT THE RECIPIENT SITE



- The PRF obtained is split into two halves
- One half is compressed to form a PRF membrane, which is placed over the prepared bed and the other half is mixed with the harvested cancellous bone graft.

Bone graft harvested from iliac crest and PRP

2. Bone Grafting- Crushed cancellous bone incorporated with PRP is grafted to the cleft site. Take photographs with the graft in place.

3. Wound Closure & Dressing- The oral layer is sutured with 3-0 vicryl so as to get a water tight closure. After suturing photographs are taken. The wound is covered with a thin layer of zinc oxide eugenol paste & an extraoral pressure dressing is placed on the upper lip.

Cortico-cancellous Bone mixed with PRP, grafted into the defect.

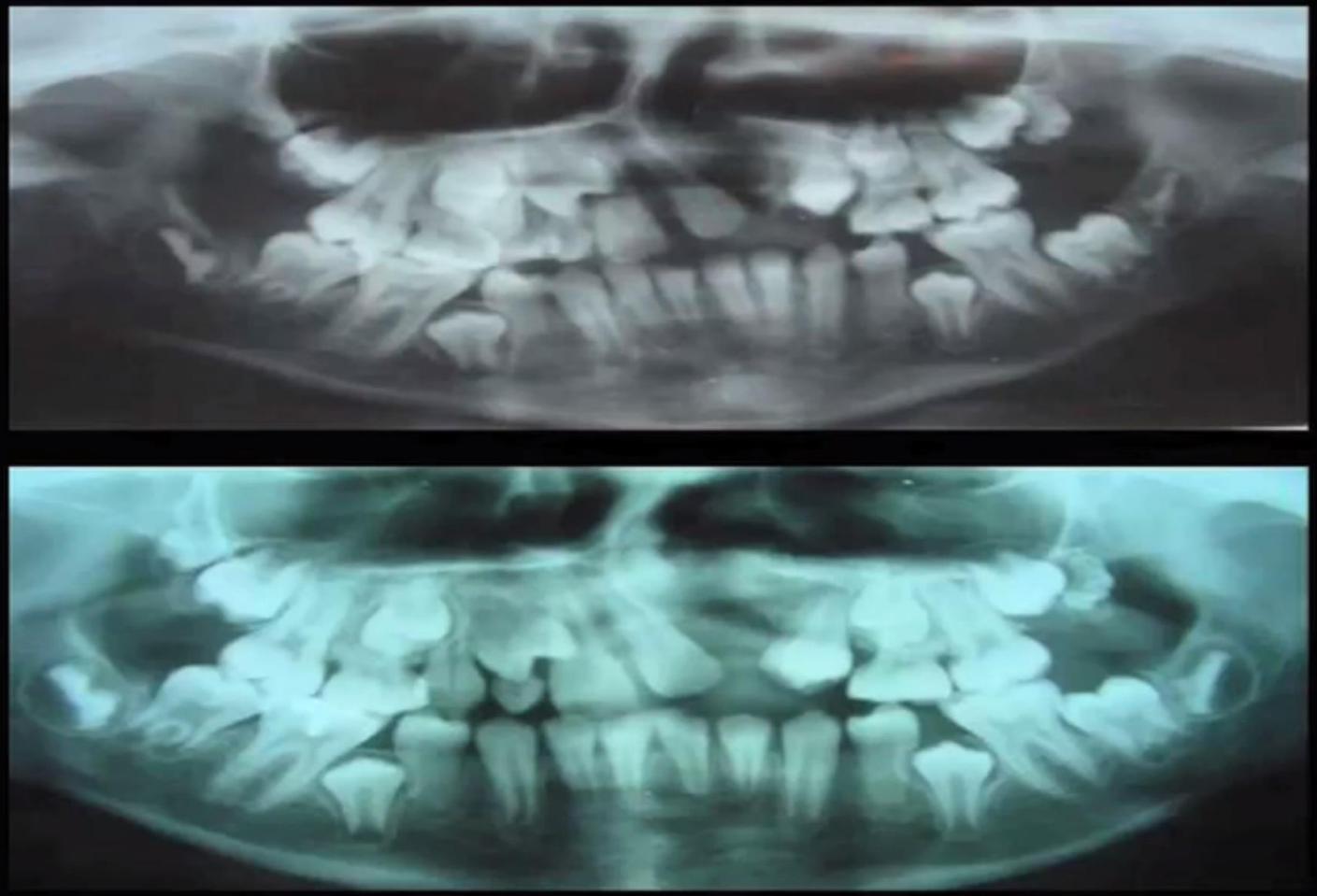
V-Y Closure increase vestibular length with water tight suturing

- After the reversal of anesthesia & recovery, the patient is shifted to the ICU & is put in a recovery position.

- 100% oxygen is given & is gradually tapered as per the anesthetist's advice.

- Vital signs are monitored periodically & a close watch is kept to check on post operative bleeding.

- Patient's attendants are counseled appropriately & the post operative medications are advised.



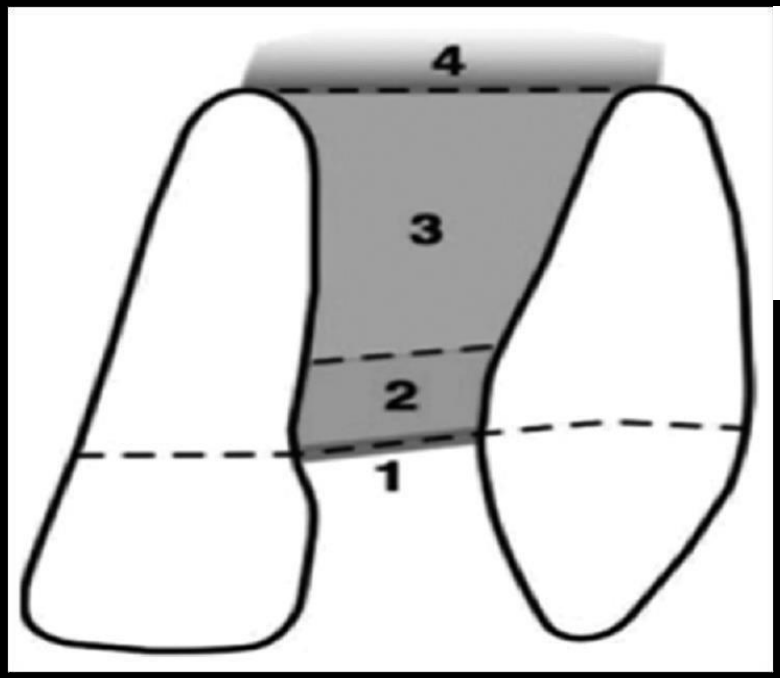
Pre- and post- op OPG x-rays

Radiographic assessment of Alveolar Bone Grafting

- Bergland Scale
- Chelsea Scale
- Kindelan Scale

Bergland Scale

- 4 point scale
- Semi quantitive scale
- Measure interdental bone height
- Requires post operative peri apical X-ray



- Grade I: Ossifications equals the height of the interalveolar septum
- Grade II: Ossification at least at 75% of the interalveolar septum
- Grade III: Ossification is <75% of the interalveolar septum height
- Grade IV: No evidence of bone integration.

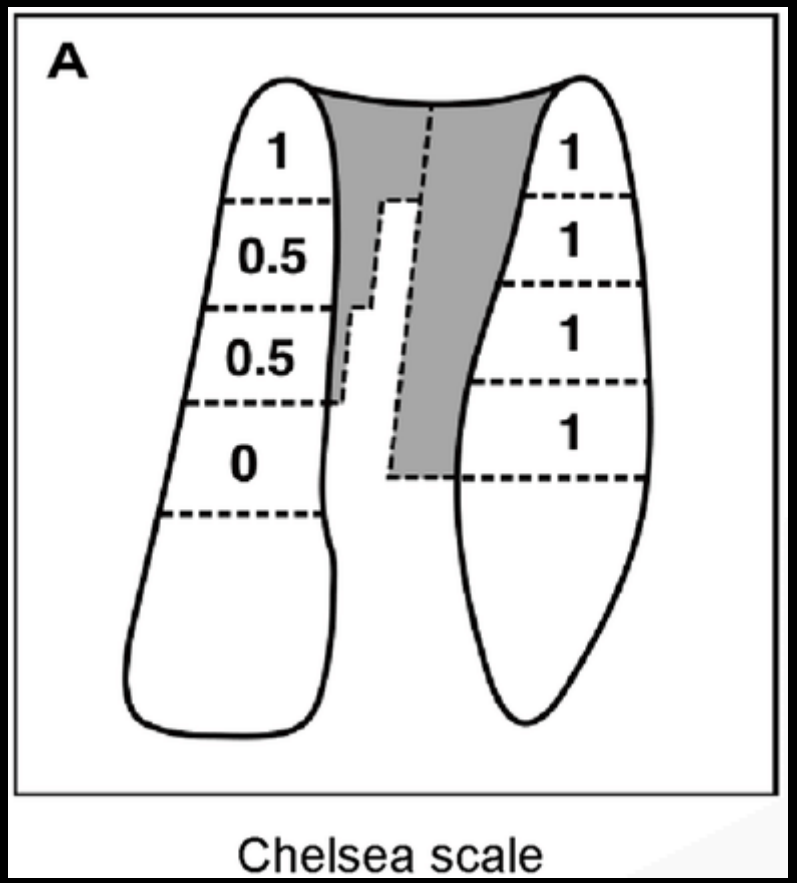
Perez-Gonzalez A, Shinji-Pérez K, Theurel-Cuevas A, Jimenez-Murat Y,Carrillo-Córdova JR. Autologous alveolar bone graft integration based on the Bergland scale in patients with primary lip and palate cleft: Experience in a third level hospital in Mexico City. J Cleft Lip Palate Craniofac Anomal 2017;4:154-7

Kindelan scale

- Similar to Bergland technique - 4 Point Scale
- Measure bone formation on a 4 point scale between Pre-op and Post-Op X-rays
- Uses oblique Occlusal view X-rays instead of peri-apical view

Chelsea Scale

- 8 Point Scale
- Assesses position of bone in relation to entire root length in cleftand cleft midline
- Partial bone fill between root and midline is given 0.5 value
- Full bone fill gets a value of 1



Chelsea scale

European Journal of Orthodontics 25 (2003) 35–41

Comparative reproducibility of three methods of radiographic assessment of alveolar bone grafting

Claire Nightingale*, Helen Witherow**, Fiona D. A. Reid*** and Raymond Edler*
*Department of Orthodontics and **Norman Rowe Maxillofacial Unit, Queen Mary's University Hospital, Roehampton and ***Department of Public Health, St George's Hospital Medical School, London, UK

- None of the three scales were more reproducible than the others
- The agreement between examiner were also similar across the three scale
- Neither occlusal nor peri-apical radiographs were found to enable greater reproducibility for assessment

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Bring the Smile Back

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