

Evolution and recent advances in pre-prosthetic surgery - A Literature Review

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Abstract

Aim: This paper review is marked the evolution and most important procedures and techniques involved in pre-prosthetic surgery and recent advances in pre-prosthetic surgery to maintain oral function and aesthetics of the patient.

Background: Following the loss of natural teeth after extraction, the bone begins to resorb. This resorption continues and accelerates in denture wearers and it

affects mandibular alveolar ridge than maxilla. To reduce or stop this type of bone resorption the pre-prosthetic surgery is performed. Pre-prosthetic surgery is performed to reform or redesign hard or soft tissues by eliminating biological hindrance to receive comfort and stable prosthesis. Various procedures might be performed for preparation of mouth for denture or for fixed prosthesis it includes bone smoothing and

reshaping ,excess bone and gums removal ,recontouring of bone .

Review Results: Current evidence-based pre-prosthetic surgery and different recent advances for improving aesthetic dentistry are discussed. The Pre-prosthetic surgery recent advances mainly focused on proper assessment of the case scenario including the associated hard and soft tissue and selection of a proper technique for the correction of the same.

Conclusion: Newer procedures are being developed all the time and are gradually being integrated in dentistry. The practitioner should fulfil the patient regarding oral function that should be done by pre prosthetic procedures performed for better oral function and aesthetics. Our ongoing progress toward better advance approaches should be include freshly offered methodologies in pre-prosthetic surgery.

Clinical significance: There is drastic increase in aesthetics demand of peoples for the dental procedures in recent years. With the evolution of innovative techniques, clinicians can fulfill the patient's aesthetic demands and oral function. Thus it is important to be updated in this field about the current innovative approaches in the pre-prosthetic surgery.

Keywords: Alveolar ridge, bone augmentation surgery, Piezosurgery, Pre-prosthetic surgery, prosthesis, ridge split

Introduction

Pre-prosthetic surgery a close relationship between prosthodontics and oral implantology and maxillofacial surgery and it is important aspect of dentistry.¹ Restoring the oral function following loss of the natural dentition and subsequent alveolar bone resorption is often a complex situation, requiring extensive cooperation between the prosthodontist and oral and maxillofacial

surgeons. In 1967 MacIntosh and Obwegeser the principles of Pre-prosthetic reconstructive surgery were first introduced.² Kazanjian³ reported on the prototype of labiobuccal vestibuloplasty procedures to provide an additional denture-bearing surface for increased denture stability then the Pre-prosthetic surgery emerged from a ridge trimming service to a truly reconstructive surgery.⁴ Pre-prosthetic surgery involves operations aiming to eliminate certain lesions or abnormalities of the soft and hard tissues of the jaws so that the subsequent placement of the prosthetic appliances is successful.⁴ In 1876, Beers advocated “excisions of alveolus after extraction of teeth.” He also specifically described if the alveolar process is unnaturally prominent the cutting away of the bone.⁵ However , at times the alveolar bone gets resorbed soon due to prolonged use of an ill-fitting denture, leading to poor retention of denture which leads to uncomfortable and difficult for denture wearers.⁶ In Oral Implantology the pre-prosthetic surgery is most important before placement of implant certain pre-prosthetic procedure required in compromised bony ridges such as ridge split techniques ,alveoloplasty, alveolectomy, ridge augmentation procedures .In soft tissue compromised patients soft tissue corrections required for successful implant In recent years various advances are seen in pre-prosthetic surgery such as by using laser therapy, by using ultrasonic devices, alveolar distraction osteogenesis ,tissue engineering and cell culture techniques.

Pre-prosthetic Surgical Procedures can be Classified as:

1. Ridge correction procedures
 - A. Hard-tissue correction
 - Alveoloplasty
 - Alveolectomy

- a. Reduction of,
- b. Genial tubercles
- c. Mylohyoid ridge,
- d. Maxillary tuberosity.
- e. Correction of tori, exostoses.
- B. Soft-tissue correction
- I. Frenectomy
 - a. Labial
 - b. Lingual
 - c. Excision of hypertrophic tissues
- 2. Ridge extension procedures
 - a. Vestibuloplasty
- 3. Ridge augmentation procedures
 - 1. Mandibular Augmentation
 - a. Superior border
 - b. Inferior border
 - c. Interpositional grafting
 - d. Visor osteotomy
 - e. Combined with orthognathic surgery
 - 2. Maxillary Augmentation
 - 3. Alveolar distraction osteogenesis
 - 4. Correction of Abnormal Ridge Relationship

Recent Advances

- 1. Ridge Split Technique
 - a. Alveolar ridge split technique using piezosurgery.
 - b. Maxillary single-stage alveolar ridge-split procedure
 - c. Bone spreading technique.
 - d. Split-crest technique extension crest technique.
- 2. Tissue Engineering

Ridge Correction Procedures

1 Hard Tissue Correction

A) Alveoloplasty

Alveoloplasty is resurfacing and restructuring of the of the alveolar process bone to provide a functional skeletal

relation. In tooth extraction process such as in single or multiple tooth extraction alveoloplasty is indicated. In 1876, beers described alveolectomy where a large portion of alveolus is removed with forceps.⁵ Reduction of the alveolar margin after dental extraction given by Willard, in 1853.⁷ Molt, performed alveoloplasty retaining the interdental septum in 1923.⁸ Alveoloplasty by removing interseptal bone and collapsing buccal cortical plate. performed by Dean, in 1936.⁹ In 1966 Obwegeser modified this technique, by fracturing both palatal and labial cortices to reduce premaxillary protrusion.¹⁰ [Fig. 1]

B) Alveolectomy

Genial Tubercle Reduction

Genial tubercles mostly seen in mandible due to the area of attachment of genioglossus muscle. It is seen mostly in the anterior portion of the mandible. It increases continuously and becomes prominent when mandible begins to undergoes resorption. Pronounced tubercle should be trimmed or smoothed or released.⁴

C) Mylohyoid ridge

When there is extensive resorption occurs in the ridge prominent cases and create difficulty for the smooth placement of denture; hence, the need for ridge reduction occurs. Due to the sharp mylohyoid ridge denture flanges impinge and patient feels discomfort and experiences pain. In many cases where implant placement is not possible, the dentures become a necessity and the mylohyoid ridge reduction needed.¹¹

D) Maxillary Tuberosity

In adequate interarch space for proper denture construction in the posterior area and a firm mucosal base of consistent thickness over the alveolar ridge denture-bearing area the soft tissue maxillary tuberosity reduction should be necessary.³ For the placement of

dentures the reduction of the tuberosity may be needed to create space.¹¹The engorged tuberosity is trimmed to the desired level and the excessive tissue is removed from both palatal and buccal side. The amount of bone removal can be dictated by a surgical guide that was created from study models. To remove the bone Rotary instrumentation, a bone file and rongeur may be used and the flaps are trimmed to leave the excess redundant tissue and sutured in place. Different technique for the reduction of the tuberosity proposed by Guernsey¹². He advised placing a horizontal incision superiorly in the vestibule from the premolar area to the posterior aspect of the maxillary tuberosity and a mucoperiosteal flap is released inferiorly to get access to the tuberosity region.[Fig.2]

E) Correction Of Tori, Exostosis

Buccal exostoses are mostly seen on the buccal side of the upper ridge. They interfere with border seal and proper adaptation of the flanges. They also impede with proper flange contouring and teeth setting. They are managed by surgical reduction. Torus palatinus or palatal torus is a benign, slowly growing, bony projection of the palatine processes of the maxillae and occasionally of the horizontal plates of the palatine bones. The surgical removal of the palatine torus is advised in pronounced torus. Torus mandibularis are mostly located in the canine-premolar region but are also appear as multiple bony nodules extending from the incisor to the molar regions and in these cases mandibular tori are removal indicated [Fig 3]

B. Soft Tissue Corrections

I. Frenectomy

High attached frena can cause loss of border seal that results in the poor retention of the upper denture. The deep labial notch on the denture to accommodate such

prominent frena will weaken the denture and increase the chance of midline fracture. strong and active frenal attachments interfere with the placement of dentures and the relief of attachments are needed. Various incisions like v-y, z plasty, and diamond-shaped incisions are used in frenectomy procedures.¹¹

a. Labial Frenectomy

Instability causes due to the abnormal frenal attachment gets irritated by the denture flanges. The denture area can be relieved but it appears to be unaesthetic, so frenectomy needed. Z plasty and V- Y procedure is used to eliminate the abnormal attachment.

b. Lingual Frenectomy

The abnormal frenal attachment gets irritated, by the denture flanges leading to instability. The denture area can be relieved but it may be unaesthetic, so frenectomy needed. Elimination of the abnormal attachment is done by Z plasty. Another method is the V- Y procedure but has a drawback of creating excessive bulk of tissue at the depth of vestibule.

a. Excision Of Hypertrophic Tissues

Epulis Fissuratum

Epulis fissuratum is the hyperplasia of sulcular epithelium due to chronic irritation, painful condition from an ill-fitting denture. The hyperplasia is in the form of 2-folds one outer and inner and the sulcus in between may be ulcerated.⁴

Papillary Hyperplasia

Papillary hyperplasia is the result of ill-fitting denture, due to the presence of palatal relief chamber in the denture or a low-grade infection with Candida. surgical removal is advised in case of any residual lesions that fail to resolve. The various methods available are sharp excision, electrocautery, laser excision, laser ablations, cryosurgery and curettage with large rotary burs.⁴

2. Ridge Extension Procedures

a. Vestibuloplasty

In case of the shallow vestibule to widen denture-bearing area vestibuloplasty should be performed. There are different techniques of vestibuloplasty. Most of the procedures provide access from the buccal aspect of the mandible.¹³

a. Kazanjian vestibuloplasty

A mucosal flap taken from the alveolar ridge is elevated from the underlying tissue and sutured to the depth of the vestibule. The inner portion of the lip is allowed to heal by secondary epithelialization.¹³

b. Clark's vestibuloplasty

Clark's technique uses mucosa pedicled from the lip. Horizontal incision is taken from canine to canine between immobile gingiva and mobile gingiva. After supraperiosteal dissection the mucosa is to be sutured at the depth of the vestibule. The denuded periosteum heals by secondary epithelialization. It is possible to use tissue graft on exposed periosteum. The healing process is more rapid in this situation.¹⁴ [Fig.4(1) & Fig.4 (2)]

c. Corn vestibuloplasty

This vestibuloplasty is similar to Clark's vestibuloplasty. Difference is that horizontal incision is through soft tissue and mucoperiosteal flap is dissected, and the bone is exposed. Disadvantages are it is more painful procedure and healing is longer.¹⁴

d. Obwegeser vestibuloplasty

Obwegeser describes this vestibuloplasty method in which labial extension procedure and Trauner's procedure provide a maximal vestibular extension to both the lingual and buccal aspects of the mandible.¹⁴

3 Ridge Augmentation Procedures

1. Mandibular Augmentation

Superior Border Augmentation- When severe resorption of the mandible occurs results in inadequate height and contour potential risk of fracture or when the treatment plan calls for placement of implants in areas of insufficient bone height or width a superior border augmentation with a bone graft is indicated^{15,16}

Inferior Border Augmentation- The first clinical use of an inferior border technique for augmentation of the atrophic mandible reported by Sanders and Cox. This procedure is rarely used for augmentation of Mandibular bulk with inferior grafting using iliac crest bone grafts and is secured with rigid fixation.¹⁷

Hydroxyapatite Augmentation of the Mandible: In augmentation of resorbed alveolar ridges hydroxyapatite is used. Because bony augmentation of alveolar ridges often undergoes resorption in a short period of time and nonresorbable hydroxyapatite holds the promise of avoiding a recurrence resorption.¹⁷

Guided Bone Regeneration (Osteopromotion) : A membrane is used to cover an area where bone graft healing or bone regeneration is desired. The concept of osteopromotion is based on the ability to exclude undesirable cell types, such as epithelial cells, fibroblast from the area where bone healing is taking place.¹⁸

Visor Osteotomy: The visor osteotomy is performed to increase the height of mandibular ridge for denture support. It consists of central splitting of the mandible in buccolingual dimension and the superior positioning of the lingual section of the mandible and which is wired in position. Cancellous bone graft material is placed at the outer cortex over the superior labial junction for improving contour of the ridge.

Modified Visor Osteotomy: It consists of splitting of mandible buccolingually by vertical osteotomy only in the posterior regions and a horizontal osteotomy in the

anterior region. Corticocancellous bone grafts particles with hydroxyapatite granules are placed in the gap between the inferior and superior anterior segments. Remaining of the graft material can be molded on the buccal aspect of the posterior segments.¹⁹

Maxillary Augmentation

In maxillary augmentation, a severe increase in interarch space, interference from the zygomatic buttress area, loss of palatal vault, and absence of posterior tuberosity notching may prevent construction of proper denture

Onlay Bone Grafting: It is indicated when there is severe resorption of the maxillary alveolus is seen that results in the absence of clinical alveolar ridge and loss of adequate palatal vault form²⁰

Interpositional Bone Grafts: It is indicated in bone-deficient maxilla, where the palatal vault is found to be adequately formed but ridge height is insufficient.

Maxillary Hydroxyapatite Augmentation HA is readily available and eliminates the need for donor-site surgery and it is easily placed in an outpatient setting. HA can be used to contour and eliminate minor ridge irregularities, undercut areas in the maxilla.²¹

Alveolar distraction osteogenesis -It is based on the concept of bone distraction along a vector that is transverse to the long axis of the bone, which results in bone formation. Advantage of distraction osteogenesis is that there is no additional surgery required at the donor site. Another advantage is that the coordinated lengthening of the bone and associated soft tissues.^{20,21}

Correction of Abnormal Ridge Relationship

In totally edentulous patients, with the patient's jaw at proper occlusal vertical dimension the interarch space and the anteroposterior and transverse relationships of the maxilla and mandible must be evaluated. In the

diagnostic phase may require the construction of bite rims with proper lip support.

Graft Materials: Iliac bone crest and rib have traditionally been applied to augment the jaws. A bone regeneration method, which employs a vitalium mesh tray containing haematopoietic bone marrow encased in a nylon-reinforced Millipore filter suggested by Boyne²². The filter prevents the connective tissue elements accessing the defect and thereby enhances the osseous regeneration. The concern regarding the graft material is the resorption shrinkage in the future. Many attempts are done by surgeons to minimise the resorption shrinkage of the grafted bone. The use of inferior border rib grafting for augmentation proposed by Sanders and Cox²³. The literature suggests the use of pure cancellous iliac graft, iliac cortical— cancellous sectional grafts with appropriate immobilisation showing excellent healing even in the event of occasional incision dehiscence. The subcortical insertion of bone graft advocated by Danielson and Nemarich.²⁴ Farrell²⁵ and his associates went ahead with interpositional bone graft with simultaneous vestibuloplasty.

Augmentation with Synthetic Graft Materials- For the augmentation of the atrophied ridge.- A myriad of materials is used. It consists of resorbable and non resorbable materials. Hydroxyapatite, a calcium phosphate material with physical and chemical attributes and is nearly similar to dental enamel and cortical bone has been successfully using for decades. Studies by Kent et al.²⁶ and Drobeck et al.²⁷ illustrate the usage. Hydroxyapatite in combination with corticocancellous autogenous bone for augmentation used by Kent et al.²⁶ This combination provides additional strength to the mandible, as advised by Jarcho et al.²⁸ Though block forms are used by Frame and Brady²⁹ the granular forms

also get used in the augmentation process as guided by Kent et al.²⁶ A single midline vertical incision is used when anterior mandible needs augmentation, while for the complete augmentation of mandible, bilateral vertical incisions anterior to mental foramen are used. A subperiosteal tunnel is formed and which can be assessed by a dental mirror and the syringe loaded with graft material is inserted through the tunnel and delivered in place. When the tunnel is filled with graft material, the incision is closed with interrupted or horizontal sutures. Denture can be placed at about 1 month in cases where augmentation is carried out by hydroxyapatite alone or 6–8 weeks in which both hydroxyapatite and bone are used together. If vestibuloplasty is planned, Kent²⁶ advocated a waiting period of 8 weeks after graft placement.

Recent Advances In Pre-Prosthetic Surgery

Implants, In recent years, dental rehabilitation of edentulous patients using implant-supported prostheses has been presented a significant treatment alternative to conventional restoration with a meaningful improvement in masticatory function and well-being of edentulous patients. The bone resorption has been reduced by autogenous bone graft with osseointegrated implants. With the use of either round burs or diamond disks can help to remove the bulk of the bone: however, these instruments like round burs and diamond burs generate heat, which might affect bone healing and it will lead to bone necrosis. The implants can be inserted at the same time as the bone is widened, which reduces morbidity as well as treatment costs and time this is advantage of alveolar ridge split technique.

Ridge Split Technique

Tatum described the alveolar ridge splitting as a new technique of alveolar ridge expansion.³⁰ The technique

was later modified by Simion et al.³¹ and Scipioni et al.³². Originally, the splitting is performed with chisel and hammer, then with rotating or oscillating saws^{33,34}. A new method for ridge expansion is the use of ultrasound for medical surgery. Piezoelectricity was discovered in 1880 by Jacques and Pierre Curie³⁵, and its use for surgery was explored in the 1940s³⁶. Traditionally the practitioners have created the split in the bone before expanding it by using a hand mallet. However, nowadays piezoelectric devices have been used. The risk of displacement of bone fragments and vertigo associated with hand mallet percussions has been overcome with the help of piezo surgical system.

Alveolar ridge split technique using Piezosurgery (moro et al 2017)³⁷

Vercelotti et al 2000³⁸ introduced the use of piezoelectric surgery in the treatment of atrophic jaw. The advantage of using piezosurgery is that it will decrease the complications and it is safer, easier and that are encountered when done with osteotomes. In first stage grooving of the center by using low power of Piezosurgery devices should be performed, then the osteotomy site should be prepared. (Resorbable membrane covering the grafted materials), first the grafting material should be placed then the resorbable membrane and suturing is done after grafting procedures are done.³⁹

Maxillary single-stage alveolar ridge-split procedure⁴⁰

The crestal corticotomy can be initiated by using a 15c blade, piezo tips or 701 bur. The use of 15C blade to make a small initial indentation to gain access directly to the medullary bone. Later with the help of chisel osteotomes split is widened and goes apically till the

vestibular depth and then the pressure is transferred laterally for the green stick fracture to take place.³⁹

Apical U-Shape Splitting Technique(Wu Et Al In 2019)⁴¹

The principle for U shape splitting concentrates on expanding the the most concave area and the thinnest area leaving alveolar crest alone Wu et al in 2018 reported that the in comparison to GBR technique use apical u shape split procedure resulted in greater ridge width gain in .⁴¹ The ridge splitting technique with immediate loading is preferable in anterior maxilla.^{42,43}The advantages of this technique i.e apical U shaped procedure over GBR include its ability to maintain the space.³⁹

Bone spreading technique (nishioka et al 2010)⁴⁴

Summers osteotomy technique is an alternative technique which involves less trauma to the bone while expanding it followed by implant placement.³⁹

Split-crest technique.extension crest technique chiapasco et al ⁴⁵

Split-crest technique.extension crest technique proposed by chiapasco et al ⁴⁵.This technique uses the ultrasonic bone surgery device and piezoelectric device to make precise cuts and osteotomies for splitting the alveolar crest which give more predictable outcome. Piezoelectric transducers have more energy in terms of the bone cutting. Piezo-electric materials when subjected to intense electric field, in the 500–750 V/mm range.⁴¹ The rationale of the treatment is the trauma to the bone due to the use of chisels.³⁹

Extension crest technique chiapasco et al⁴⁵

Chiapasco et al suggested the use of a new device in 2006 called the extension crest device . It was anticipated by the used for the sagittal osteotomy in case of the atrophied ridge. A slow and steady expansion of

the sagittal osteotomy and also reduces the risk of the buccal plate has been provide by extension crest device .

Lasers : Today, increasingly versatile and sophisticated and new lasers are available. Based on the choice of different technologies, materials and a diversity of wavelengths these leasers vary in an applications. As the laser has the ability to vaporize soft tissues without bleeding and wound healing without scar formation and Without any deformation of the healed site. Moreover, This is the most important effect in the field of pre-prosthetic surgery.so there is no need for any surgery as any loss in vestibule lengths provoked by the suture is avoided. This wavelength is perfectly adapted for patients requiring soft tissue preparation management. New modalities have been proposed and used in SRT like laser (erbium: yttrium–aluminum- garnet, chromium-doped: yttrium-scandium-gallium-garnet), micro saw devices, Erbium and piezoelectric devices.

Tissue Engineering: The science of growing living human tissue for opens new perspectives in medical care transplantation and will have a positive influence in the field of pre-prosthetic surgery. Cell culture technology, originally described for cultured skin and mucosal grafts and has opened a new era in the field of oral reconstructive surgery. The major merits of the cell culture is the expansion of a small biopsy specimen into the transplantable mucosal tissue by two to three orders of magnitude within a few weeks. Palatal mucosa was cultured on the culture media and transplanted to replace gingival mucosa and demonstrated that 4 months later the grafts had formed a well-differentiated keratinizing mucosa similar to the palatal mucosa in situ. Studies on production of ex vivo intraoral skin/mucosal graft gave promising results.

Discussion

The pre-prosthetic surgery have first proposed by Willard in 1953. After that the various principles of preprosthetic reconstructive surgery has been evolved. Preservation of alveolus after extraction of tooth to remove interferences which occurs during mastication of food. For the construction of the prosthesis the recountouring and reshaping the bone is establish which leads to stability of the prosthesis and maintain oral functions. Various techniques such as ridge extension procedures, ridge augmentation procedures in compromised alveolar ridge, vestibuloplasty, hard and soft tissue correction came into existence for the better aesthetic of the patient. In the recent year the advance pre-prosthetic surgical techniques developed such as lasers, ridge split technique, tissue engineering etc to provide better treatment in advanced approach which result in the maintain hard and soft tissue health and longevity of the prosthesis.

Conclusion

Nowadays there is hype in the field of pre-prosthetic surgery for improving aesthetics along with optimal health and function. Contemporary dentistry not only offers us with superior materials and technology, but it can also assures that the procedures are performed in a minimally invasive manner with advanced developed techniques and which focus on ideal function and highest level of aesthetics concern. Pre-prosthetic surgery is the procedure should take into consideration before prosthetic planning of the patient for stability of the prosthetic and oral function. Newer advanced procedures are being developed all the time and are gradually being integrated into dental practice. The practitioner should fulfil the patient regarding oral function that should be done by pre prosthetic

procedures performed for better oral function and aesthetics. Our ongoing progress toward better advance approaches should be include freshly offered methodologies in pre-prosthetic surgery.

Clinical significance

There is drastic increase in aesthetics demand of peoples for the dental procedures in recent years. With the evolution of innovative techniques, clinicians can fulfill the patient's esthetic demands and oral function. Thus it is important to be updated in this field about the current innovative approaches in the pre-prosthetic surgery.

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Legend Figures

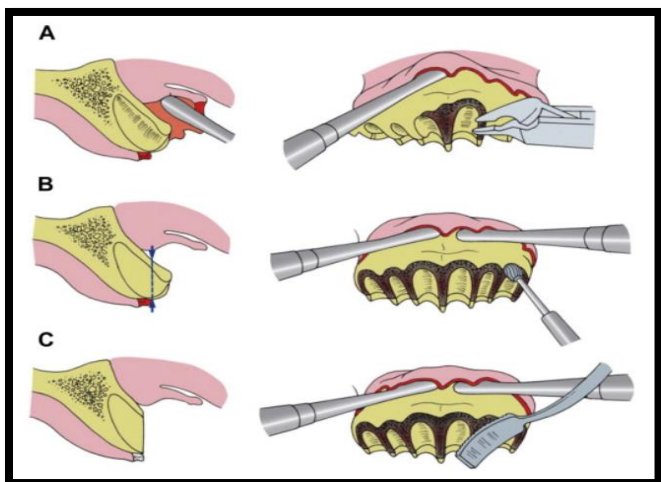


Fig. 1: Alveoloplasty techniques using hand and rotary instruments. (A) Flap elevation, alveoloplasty using rongeurs (B) Alveoloplasty using rotary instrumentation.(C) Final contouring and smoothing using a bone file.

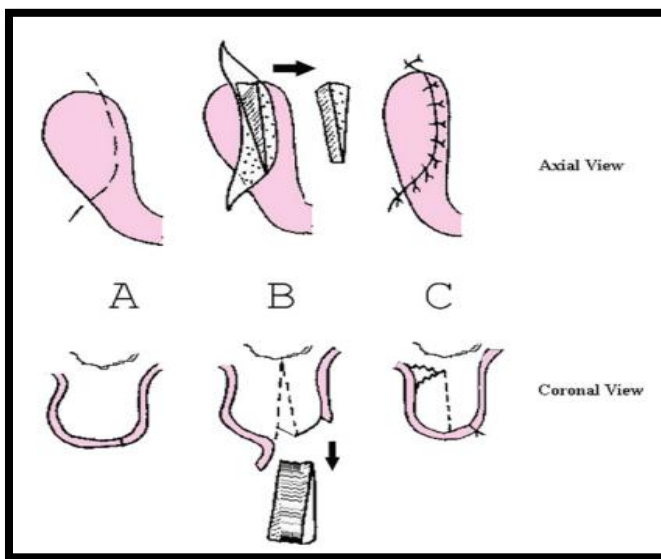


Fig.2: Schematic representation of the technique used for reduction tuberoplasty of a large bony tuberosity. Axial view (top), coronal view.

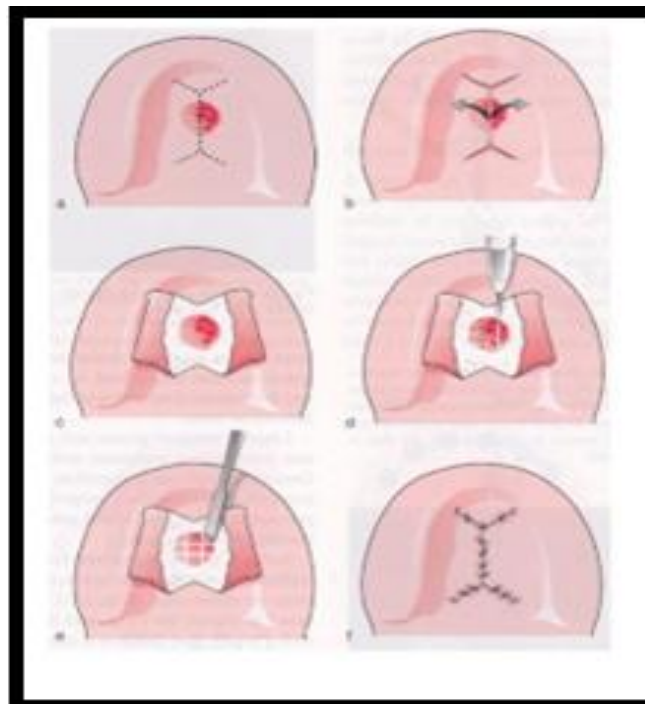


Fig. 3: a), b) Midline incision made across the bony mass with lateral extensions anteriorly and posteriorly c) mucoperiosteal flaps are reflected to expose the bony mass, d) A bur is used to divide the torus into small pieces . e) A chisel is used to elevate the small fragments of bone from the hard palate f) the wound is debrided and the bone is smoothed with a bur ,then sutures are placed to close the wound.



Fig.4: (1) Patients with inadequate vestibular depth



Fi.4 (2) Clark's Vestibuloplasty