

DISTRACTION OSTEOGENESIS WITH VERTICAL RIDGE AUGMENTATION

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Review Article

Abstract

One of the most common challenges faced by the dental professionals is resorbed alveolar ridges which can be in horizontal and vertical dimension . Alveolar distraction osteogenesis is one of the mode of treatment for improving the deficient areas of alveolar ridges.

Alveolar distraction osteogenesis is biological process which involves progressive incremental traction between the vascularized bone segments in order to gain new bone formation. Osteotomy is usually performed which is followed by placing a osteo-distractor device which controls the separation process. By using this technique, the use of bone graft can be avoided as it produce same character and morphology of bone. It results into growth of the soft tissue with development of new bone on deficient ridge. As bone height is restored by this technique ,it is feasible to place longer dental implants.

This review discuss about ride augmentation and various procedure which are performed to restore resorbed alveolar ridge. It emphasize on importance of alveolar distraction osteogenesis with some history of the technique on the basis of evidences available.

To conclude, distraction osteogenesis is an efficient method to restore the alveolar ridge height for better adaptability of dental implants.

Keywords: *distraction osteogenesis, ridge augmentation, dental implants*

Introduction

In cases like periodontal disease, marginal resection in malignancy, tumours, cysts and dental extraction, there is loss of posterior teeth which is followed by resorption of alveolar bone. Resorption accelerates during the 1st year of extraction and usage of dentures.(1,2)

We will all agree that it is difficult to work on a deficient alveolar ridge. One cannot have a traditional approach for a procedure if there is significant amount of alveolar resorption. This may interfere with proper placement of dental implants. To increase the ridge height and size, a procedure called ridge augmentation is performed. (3)

To surpass this hurdle, various methods are available for bone augmentation which are given as follows :

“Guided bone regeneration”

“Bone grafts”

“Inferior alveolar nerve (IAN) lateralization”

“Alveolar distraction osteogenesis”

GUIDED BONE REGENERATION

Most common approach for ridge augmentation is “Guided bone regeneration”. This method includes, regeneration of bony defects which is achievable by the placement of occlusive membrane, that allows the “osteogenic cell” to colonize osseous wound, by excluding non-osteogenic cell type from the localised tissue. It cannot attain a sufficient bone height, thus cannot be used for large bony defects. (4,5)

BONE GRAFTS

As Bone generally has the ability to regenerate completely, thus by using this property bone grafting is done. Bone grafting is a type of surgical procedure that is performed to restore the missing bone so as to facilitate formation of bone and stimulate the healing of wound. Bone grafts are one of the good option for a deficiencies of up to 6 mm. But one of the major drawbacks are there is tendency of bone resorption with onlay bone grafts and also it have been observed that there is donor site morbidity with both onlay and inlay bone grafts.(6,7)

Inferior alveolar nerve (IAN) lateralization

In “nerve lateralization”, the IAN is uncovered and a pull is used for diversion of the nerve laterally in the meantime the implant is placed. The IAN is then left to fall back into position, against the fixtures. The major advantage of this technique is that, it’s a single sitting surgical intervention followed by implant placement with no donor site morbidity.(8)

“Jensen and Nock were the first to report an IAN lateralization for the placement of Osteointegrated implants in the posterior mandible area”. During this procedure any damage could be done to the IAN and there are chances of “neurosensory disturbances” of the mental nerve leading to common complication like hypoesthesia, paresthesia, and hyperesthesia. (9,10)

You might not achieve the desired amount of bone height and ratio of crown to implant ratio would be improper and in cases of bone which is severely deficient the techniques might not provide with the requirements of both the soft and the hard tissues and hence the practice of “distraction osteogenesis” has increased since the past decades.(11-13)

HISTORY

In the year 1869, Bernhard Von Langenbeck first proposed the procedure distraction osteogenesis but the first one to use it impersonally was “Alessandro Codivilla” in the year 1905. [14] In this treatment, he treated 26 people born with malformed legs he had put a pin in the heel bone, cut the femor and applied traction in every patient. (14,15) Since his experiment showed high level of complication like dead skin, dead tissue, infection, failure of bone to join therefore the method was not considered to use. (14)

There was another Russian orthopedic surgeon named “Gavriil Llizorov” who studied this method on over 15,000 people in the 1950’s. He was using it to determine optimal rate of separation using an external device to separate severe leg bones gradually. His work was one of the key for the widespread use of distraction osteogenesis.(14,16) But the very first use in the jaws was done by “Wolfgang Rosenthal” in the year 1930 and the first modern era paper describing the clinical use of “distraction osteogenesis” was published in the year 1992. (14,17)“Distraction osteogenesis” which was introduced by “Chin” and “Toth” in 1996.The process constituted of separating the bone through “osteotomy” while slowly applying traction for the regeneration and integration of the bone.(18,19)

Procedure :

In distraction osteogenesis, a procedure called osteotomy is performed which is followed by gradual expanding the gap between the bony segments which leads to bone formation. [20,21]

The procedure is divided into four parts

- 1] “osteotomy” or surgical phase
- 2] “latency period”
- 3] “distraction phase”
- 4] “consolidation phase”

In the “1st phase”–“osteotomy” – the bone is cut completely or partially or only through the hard exterior after which the device is fitted. In the “2nd phase” – “latency period” - which is usually 7 days. In this the appliance is not activated for the bone to heal. In the “3rd phase” – “distraction phase” – the device which was placed in the bone is used for the separation of the bone pieces helping to form a gap for new bone formation. In the “4th phase” – “consolidation phase” – after the required length is achieved the process undergoes a

“consolidation phase” in which the bone stability is maintained by the device to allow healing. (14)

After this phase the device is removed with the help of a surgical procedure. There are various devices used for alveolar vertical distraction which are divided into “extraosseous”, “intraosseous”, and “distraction by implants”. Devices which are frequently in use are “extraosseous device” as large amount of basal bone is essential for “intraosseous distraction” and “distraction by implants”. these devices are more susceptible to negative forces by lateral forces that may influence the vector of elongation and results in neighbouring bone resorption. Rehabilitation is difficult with these devices as it is very complex to estimate the location of intraosseous distraction devices. Contrarily large sub periosteal lumen are essential for extraosseous distraction devices, thus these devices may result in soft tissue dehiscence and exposure and may also affect the periosteal blood supply. Regardless, extraosseous distraction devices are most largely used.(5)

OSTEODISTRATOR

These are the devices used for alveolar distraction for ridge augmentation. In India, the devices available are unidirectional made up of stainless steel which are used for mandibular lengthening, vertical ramus lengthening, maxillary and midface advancement, bone transport and alveolar ridge augmentation. Various distraction devices are separately available for right and left maxillary and mandibular region. The weight is less with the height and width and a “intraoral distraction ports” is present. With the help of this traction of 25mm is possible a maximum of 25 mm distraction is possible. Four sizes are available which are 10 mm,15 mm,20 mm,25 mm. Handling of these devices are uncomplicated and monocortical screws are mainly used for fixation. Indigenous extra osseous alveolar distractor have various Components. They are (1) “Fixed buccal plate”(2) “Movable buccal plate” (3) “Central rod” (4) “activator”(22)

The device could be manually operated or there are advance devices which consists of monitorised system like the Fit Bone from Wittenstein. In the manually operated device, the separation is done by twisting the rack and pinion system. While doing this one should keep in mind the rate in which the bone is being separated, going too quickly many cause non-union which causes unstable “fibrous connective tissue” formation nor too slowly which may cause premature union. Usually the rate is about 1mm per day. Some devices connect a spring which separates the bone with the help of tension instead of being manually operated. The Fit Bone or the fully motorized system has an advantage over the manual one in accuracy, the formation of scars are less and infection risks are reduced. (14,23,24)

Every technique has various indication and contra indications. Some are described as follows:

Indications:

More than 6mm of severe alveolar bone deficiency. After bone augmentation there is absence of soft tissue closure. For bone graft harvesting if patient refuse for second donor site.

Contraindications:

The segment that needs to be transported should be of a height lower than 6mm. If either the lingual/palatal “periosteal attachments” on the transported segments are compromised then the blood supply will also be compromised for that segment. If the segments doesn't have the required width (buccolingual/buccopalatal) then the elongation may lead in fracture. The bone width between the “osteotomy” and the nasal/sinus floors or IAN is lesser than 2mm.

Various advantages of alveolar distraction osteogenesis are:

In bone augmentation procedure, distraction osteogenesis results in larger amount of bone growth is achievable. One of the added advantage of this procedure is that it allows distraction of bone as well as soft tissue. As we know in bone graft procedure, it is how difficult to obtain coverage of soft tissue that may lead to exposure of bone graft which can result into various complications. Distraction osteogenesis is also favorable because it provides improve stability as it does not involve the attached mucosa and cortical bone. Apart from this it also low infection rates and reduced morbidity of donor site

Alveolar distraction osteogenesis requires device removal as soon as the bone gain its original width which require a second operation and also the elongation procedure may lead to pain which is a kind of drawback but it can be controlled by medications.

Complications:

There are various complication with distraction osteogenesis however it can be managed. They are as follows:

There can be mental nerve and inferior alveolar injury.

It can also lead to adjacent tooth damage.

Constant masticatory forces are on the device which may result into malfunction or fracture of the device.

It device is exposed it may cause infection.

There can be interferences in occlusion

Resorption of transport segment due to inappropriate blood supply.

There can be relapse is there is short consolidation period or improper ossification. (5)

As given in above complications, these are manageable and this technique can be used to achieve a desired ortho-alveolar form of bone.

ADVANCES:

The traditional challenges have been solved by developments seen in the technology and instrumentation, for the use of bioengineering in the context of blood morphogenic proteins. Newer appliances have been developed into miniature forms for the ease of activation, usefulness and comfort during post-operative period. The patient is advised to keep the distractor device in place until the mineralization period for stability and regularity in growth. Distraction osteogenesis usually requires a 2nd surgery for the removal of the device so as to prevent infection, this can often lead to scar formation in the esthetic areas of the face. Recently there an upgradation in the devices which were traditional used that is the biodegradable device made up of a polylactic acid to outcast the 2nd surgical procedure for the removal of the device. The resorption of these implants units should neither form the foci for infection nor should it hinder the facial growth. Adaptation of these restorable materials for distraction osteogenesis gives a breakthrough in the field of surgery. (25,26)

Various other techniques are :

1. Advancement of the mandible in children for the management of airway issues.

2. A combined operation constituting of “ramus distraction” and “orthognathic surgery”
3. In cleft palate patients for the advancement of maxilla
4. “Alveolar distraction”(27)

Although there are various method for deficient ridge, considering the advantages of distraction osteogenesis, one can state that it is one of the best method for alveolar ridge augmentation.

Conclusion:

To conclude in and all for the regeneration of hard tissue and soft tissue without using any bone graft, alveolar distraction osteogenesis could be one of the good methods for bone augmentation.

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