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Review Article

Tentpole technique for bone regeneration in vertically deficient alveolar ridges: A review

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ABSTRACT

Background and objectives: Vertical augmentation is necessary in cases of extensive resorption of alveolar ridge for dental implants placement and esthetic prosthetic rehabilitation. Several surgical techniques have been used to increase bone height including distraction osteogenesis, and particulate or block bone graft.

This study was done to describe the evolution of “tentpole technique” and to review the literature related to this technique and thus evaluate its effectiveness to augment large vertical alveolar ridge defects for implant placement.

Material and methods: The evidence was obtained by PubMed and Google search using **key words: tentpole technique, ridge resorption, and alveolar ridge augmentation**. The years of search included from 2002 till 2013.

Results: The technique was described as effective on review of outcome of existing studies. It was found that considerable and stable increase in alveolar ridge height was achieved using tentpole technique.

Conclusions: Tenting of periosteum and soft tissue matrix maintains space and enhances the effectiveness of bone graft. This technique offers predictable functional and esthetic reconstruction of large vertical alveolar defects.

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1. Introduction

Extraction of teeth can result in loss of alveolar ridge width and height within first one to three years. This bone loss is exacerbated if the tooth is removed traumatically or if there are pre existing endodontic or periodontal pathologies. These often require bone augmentation to create ideal gingival contour and aesthetics.

Different surgical approaches have evolved to treat resorbed mandible. These include mandibular augmentation with rib grafts, iliac grafts, and visor osteotomy, combination of bone grafts with alloplastic materials, transosseous and transmucosal implants.

Tent pole technique has also been used for bone regeneration. It is a safe and effective method for augmentation of bone height in resorbed ridges. The main advantages of tent pole technique are stable gains in vertical alveolar bone height, successful retention of implant prosthesis associated with the procedure.

The aim of this paper is to describe the evolution of tent-pole technique from when the concept was first reported in 2002 by Marx et al. till the present scenario with its modifications and use of different bone graft materials with this technique for augmentation of bone height. Since this technique is a safe and effective method for augmentation of bone height in vertically deficient alveolar ridges so it is of interest to review the scientific data of this specific technique.

2. Material and methods

The evidence was obtained using PubMed and Google search. Articles were searched from 2002 till 2013. PubMed and Google search included keywords: ridge resorption, tentpole technique, alveolar ridge augmentation. References in relevant publications were also examined for clinical trials on this technique. These articles were thoroughly reviewed and those that fulfilled our criteria were included.

3. Review on ridge resorption

Following tooth removal varying amounts of bone resorption take place due to qualitative and quantitative changes that occur at the alveolar bone around the extraction site. Alveolar bone is a tooth dependent structure and, therefore, after a tooth is extracted dimensional bone reduction takes place both, horizontally and vertically resulting in changes that may lead to esthetic and functional problems. A deficient alveolar ridge fails to provide sufficient support and retention for dentures. This will not only compromise the soft tissue support and lower anterior facial height but also preclude dental implants placement.¹ Such deformities of the alveolar ridge may compromise future implant placement as well as esthetic results when a fixed partial denture is constructed in a visible area.^{2,13}

Alveolar ridge atrophy may cause severe alveolar ridge deficiency in horizontal and vertical direction. In cases of severe atrophy of edentulous maxilla maxillary retrognathism

may result.³ Ridge atrophy after tooth loss has been shown to follow certain patterns. The bundle bone appears the first bone to be absorbed whereas alveolar bone is gradually absorbed throughout life. The remodelling process results in ridge morphology reduced in vertical height and more palatal in relation to original tooth position.⁴ In the maxilla, the labial wall of the alveolar socket tends to resorb more rapidly after dental extraction and the ridge gradually becomes represented by the previous palatal wall (centripetal resorption). In the mandible, however, the lingual wall tends to resorb before the buccal (centrifugal resorption). This discrepancy in the resorption pattern frequently compromises the sagittal and axial intermaxillary relationship. In both jaws, the thickness of the alveolar bone ridge is compromised earlier than its height. Nonextraction etiologies of alveolar bone loss include denture-induced atrophy, trauma, periodontal disease, congenital alveolar defects, and tumor resection.

3.1. Classifications of alveolar ridge⁵

- A. In 1963, Atwood described 6 classes of alveolar ridge atrophy⁶
 - I. Preextraction normal bone.
 - II. Post extraction normal bone: after extraction and before resorption started.
 - III. High well rounded, adequate in height and width.
 - IV. Knife-edge, adequate height, inadequate width.
 - V. Low, well rounded, inadequate height and width.
 - VI. Depressed ridge.

- B In 2004, Juodzbalys and Raustia, using panoramic x-ray, computerized tomography, and ridge-mapping calipers with 347 patients, classified alveolar ridge atrophy into 3 types:⁷

Type I: Alveolar height is ≥ 10 mm and width is ≥ 6 mm and the vertical defect in the anterior region is ≤ 3 mm, which is optimal for implant placement.

Type IIA: The height is ≥ 10 mm and the width is 4–5 mm: narrow edentulous jaw dental segment (narrow eJDS).

Type IIB: The height is 4–9 mm and the width is ≥ 6 mm (shallow eJDS).

Type IIC: The height is 4–9 mm and the width is 4–5 mm (shallow and narrow eJDS).

Type IID: The height is ≥ 10 mm and the width is ≥ 6 mm, the vertical cosmetic defect in an anterior region is > 3 mm from the crest of the alveolar bone to the necks of adjacent teeth.

Type III: The height is < 4 mm and the width is < 4 mm (too shallow and too narrow for implantation).

- C According to its density, alveolar bone has been classified into 4 types by Misch (2008):

1. D-1 bone: *Dense compacta*; almost entirely composed of cortical bone, it is found in the anterior mandible, and this can withstand substantial loads because of its highly mineralized matrix.
2. D-2 bone: *Porous compacta* and coarse trabecular bone; it is commonly located in the posterior mandible and sometimes in anterior maxilla.

3. D-3 bone: *Porous compacta* and fine trabecular bone; found primarily in the anterior maxilla, it is more fragile than D1 and D2, and its bearing ability to load is reduced.
4. D-4 bone: *Fine trabecular bone*; most commonly found in long-term edentulous posterior maxilla, it is characterized by extremely thin cortical bone and reduced density of cancellous bone; it is least suitable for implant placement and has failure rates as high as 35%.⁸

Dealing with a resorbed edentulous mandible or maxilla remains a major challenge in modern dentistry.^{9,10} A deficient alveolar ridge fails to provide sufficient support and retention for dentures. That will not only compromise the soft tissue support and the lower anterior facial height, but also preclude dental implants placement, which may dramatically reduce the quality of life for patients.^{3,11}

4. Ridge augmentation

Alveolar augmentations of the deficient osseous ridge have become an integral part of therapeutic procedures in pre-prosthetic, pre-implantology surgery. The treatment should aim at preservation of natural tissue contours in preparation for implant prosthesis.¹² Aim of bone augmentation is to 1) re-establish adequate amount of bone volume for implant placement 2) restore intermaxillary ridge relationship 3) ensure esthetic results 4) fulfil the biomechanical requirement of the prosthesis and 5) to obtain healthy bone to ensure osseointegration and survival of implant.

Vertical ridge augmentation remains a challenge in the reconstruction of the atrophic maxilla and mandible. The main problem arises from the need to expand the soft-tissue envelope and achieve the proper bony architecture. Techniques that have been developed to solve or circumvent this problem include onlay bone grafting with particulate bone graft, block bone graft, barrier techniques with permanent or resorbable membranes, distraction osteogenesis, vascularised ridge splitting techniques, sinus lifts, nerve repositioning techniques, short implants, and angled implants.

The choice of technique depends on the size of defect, horizontal or vertical defect, anatomical structures, and the size of area to be augmented.

Distraction Osteogenesis is mainly used for vertical ridge deficiencies. More than 12 mm of bone height can be achieved by this method. The main advantages of this technique are: Blood supply of bone maintained, minimal risk of infection, little resorption of bone and soft tissue gain. The main disadvantages are patient compliance and cost factor. Various soft tissue changes also occur during distraction and consolidation periods. So, when a large amount of bone is to be obtained, better results are seen if total amount of distraction is divided into several time periods rather than distracting the bone at once.¹⁴

Onlay bone grafting is the positioning and securing of bone grafts on the surface of alveolar ridge. It can be either Block or Particulate onlay bone grafts. The use of Titanium mesh for localised alveolar ridge augmentation can also be used.

Histologic, Histomorphometric and radiographic evaluation of defect revealed adequate bone gain in bone height for implant placement.^{15–18} The thickness of the bone grafts should be slightly larger than the planned width or thickness. The graft taken should be 3–4 mm larger than the recipient site to allow contouring, adaptation and resorption of the graft. Block onlay grafts have more structural integrity than particulate bone as they show less resorption. Complications with traditional grafting include: Infection, soft tissue defects, Graft exposure due to soft tissue dehiscence, loss of grafting material, inadequate bone volume.

Guided Bone Regeneration (GBR) is a predictable therapeutic technique that can be used separately in a staged approach to first augment the ridge or in conjunction with implant placement when primary stability of the implant is desirable. This technique is based on filling the defect with bone grafts and/or bone substitutes and covering the material with a membrane to prevent ingrowth of epithelial and gingival connective tissue cells. The tissue regeneration promoted allows healing of bony defects within a period of 6–10 months. Possible complications are: exposure of the membrane or early breakdown of the membrane. It is mostly restricted to defects where vertical bone augmentation of about 2–7 mm is needed.

4.1. c) Tentpole technique

4.1.1. Past approaches to correct severely resorbed mandible

The first well documented series to examine the reconstruction of severely resorbed mandible was that of Baker et al., in 1979. These authors reported 50% graft resorption by 1 year and 75% resorption by 18 months when autogenous rib graft was used as onlay graft. Davis et al. also documented that only 34% of the original graft height remained in the long term follow up. These authors believed that resorption was associated with the maturation and contraction of overlying soft tissue. The grafts lost most of their original height resulting in a broad flat ridge with a tight, unresilient overlying soft tissue.

During the same time period, Stoelinga et al. advanced the concept of combining horizontal alveolar osteotomy with bone grafting and termed it “sandwich osteotomy” in anterior mandible. This procedure had significant early complications including fracture at the osteotomy joints, sensory nerve loss, pain and nonunions.

Harle later advanced the concept of vertical osteotomy with bone grafting, i.e. “visor osteotomy”. Fracture, pain, nonunion and sensory nerve loss were observed in this technique also.

By 1980, several authors introduced the concept of Hydroxyapatite (HA) in the form of blocks, particles and root form implants. With respect to HA blocks, the soft tissue contraction occurred over an avascular foreign body leading to inadequate healing of the oral incision and subsequent dehiscence. The HA particles were also forcibly displaced by contraction of overlying soft tissue and frequently created a sufficient fibrosis around mental nerve, causing neuropathies producing either sensory loss or pain.

Marx, Shellenberger, Wimsatt, Correa (2002) hypothesised that the main theme in these unsuccessful approaches was deficient soft tissue volume with its subsequent contraction

after surgical expansion when a graft is placed and failure to add sufficient bone stock to prevent fracture. Onlay grafts to these severely resorbed mandibles physiologically resorbed due to remodelling process with a net loss of bone due to contraction of soft tissue volume about the graft. Hence control and maintenance of surgically expanded soft tissue volume should prevent graft resorption over a long time period.

The authors documented the results of 64 cases of bone grafts using implant tenting concept, each with at least 3 years follow up. The vertical mandible height before surgery ranged from 2 to 6 mm. The post surgical bone height was constant at 15 mm. The gain in bone height ranged from 9 to 13 mm with a mean of 10.2 mm. In no case fracture occurred. Eight individuals experienced short term (<3 weeks) unilateral mental nerve paresthesia and 3 individuals experienced bilateral short term paresthesia. No individual reported long term paresthesia. The bone grafts in all cases were observed to maintain their bone height and become more radiographically dense over time. In these 64 cases 356 dental implants were placed and 354 were osseointegrated (99.5%) and functioning at the time of follow up (>3 years).¹⁹

Fenton, Nish, Carmichael (2006) published a preliminary report on metastatic mandibular retinoblastoma in a child reconstructed with soft tissue matrix expansion grafting, otherwise known as “tent pole graft”. They concluded that soft tissue matrix expansion grafting can be successfully utilised in the reconstruction of ablative defects in paediatric patients also.²⁰

Mastin (2007) used cortical “tentpole” grafting technique in severely atrophic alveolar ridge for implant site preparation.

Manfro, Batassini, Bortoluzzi (2008) published a case report regarding severely resorbed mandible treated by soft tissue matrix expansion (tentpole grafts). They reported a 2year follow up case of severely resorbed mandible successfully treated by soft tissue matrix expansion (tentpole) and cranial bone graft with nonremovable screw retained acrylic resin prosthesis supported by 4 dental implants.²¹

Lee B, Burstein J, Sedghizadeh (2008) published a study to evaluate the effectiveness of intraoral cortical bone grafts in combination with particulate human mineralised allograft in a “tenting” fashion in large vertical alveolar defects. This study included 10 consecutive patients with severely resorbed alveolar ridges missing a minimum of 4 adjacent teeth. Ridge augmentation was performed using cortical bone graft and human mineralised allograft in a tenting fashion. Ridges were clinically evaluated 4–5 months after augmentation. 42 implants were placed at that time. Implants were evaluated for osseointegration. One implant failed to osseointegrate. All augmented ridges retained functional and esthetic integrity after 1 year.²²

Wannfors, Johansson, Donath (2009) published a case report in which augmentation of the mandible was done by “tentpole procedure” and implant treatment in a patient with Type III osteogenesis imperfecta. Platelet rich plasma was used to accelerate bone healing. The implant supported metal ceramic restoration was serving well at 1year and 3 year follow up.²³

Lee, Rohrer and Prasad (2010) published a case series which evaluated augmentation in consecutive patients with large (>7 mm) vertical alveolar ridge defects. 1.5 mm titanium

screws were used and particulate human mineralised allograft (cancellous allograft) was placed around these screws to tent the periosteum matrix. The ridges were evaluated 4–5 months later both clinically and radiographically after augmentation and implants were placed at that time. Bone cores were taken for histomorphometric evaluation. Of the 15 patients that were treated in this study, the mean vertical augmentation was 9.7 mm. Two patients had wound dehiscence resulting in loss of graft and requiring secondary grafting before implant placement. 3 patients had screw head exposure. Five patients required 2 stage grafting procedures to achieve ridge height before implant placement. Histomorphometric analysis of 7 specimens revealed a mean bone content of 43%. Good integrity of bone with a good cancellous bone pattern and trabeculae was seen. A total of 32 implants were placed in grafted sites in 15 patients. All implants were integrated and successfully restored. Mean follow up was 16.8 months after implant placement.²⁴

Korpi, Sandor, Kainulainen, Oikarinen (2012) published a study on long term follow up of severely resorbed mandible reconstructed using tentpole technique without platelet rich plasma (PRP). The study included 22 healthy patients (3 men and 19 women) with edentulous mandible of 6 mm or less of vertical height and with a history of conservative prosthodontic treatment failures in age group ranging from 51 to 72 years. Endosseous dental implants were placed in the alveolar ridge of anterior mandible and covered with cancellous bone harvested from posterior iliac crest without addition of PRP to the bone grafts. 3–9 years follow up was done. The post-operative course was uneventful and no surgical infection was observed. Three months post op Orthopantomogram showed grafted bone density close to that of surrounding alveolar bone. The bone height was same as the height of dental implant at crest of alveolar ridge. The mean alveolar ridge augmentation was 6.3 mm. Mental nerve paresthesia was seen immediately after surgery and mild long term unilateral nerve sensibility disturbance was seen only in 2 patients. In total, 88 dental fixtures were placed of which 86 had correct axial inclination. At the time of re-entry 5 of 88 sites required removal of hyperplastic soft tissue for optimal abutment placement and hygiene. Lack of a control group in this study made it difficult to determine the role of PRP in this procedure.²⁵

Kuoppala, Korpi, Oikarinen (2013) studied the outcome of treatment of implant retained overdenture in patients with extreme mandibular bone resorption treated with bone grafts using a modified tentpole technique. 17 edentulous patients (age range 54–77 year) with severely resorbed mandible were treated with corticocancellous graft harvested from posterior iliac crest using a modified tentpole technique and implant overdenture. Platelet rich plasma was not used in this. A bar was used to splint the implants and final prosthesis with implant connection were completed approximately 7 months after surgery. The mean follow up time was around 5 years. Patients filled OHIP-14 questionnaire concerning their oral health related quality of life. Of the 67 implants placed, 2 implants were lost. Mental nerve paresthesia and some pain at graft site was reported. No local wound infections were seen. Stability of overdenture was good in 58.8% of the cases and retention was good in 64.7%. The most usual complication

Table 1 – Comparison of different studies based on soft tissue matrix expansion technique.

	No. of cases	Presurgical height	Bone augmentation achieved	No. of implants placed	No. of implants osseointegrated	Complications, if any
Marx (2002)	64	2–6 mm	9–13 mm	356	354	Short term mental nerve paresthesia in 8 pts.
Lee (2008)	10	NA	NA	42	41	NA
Lee, Rohrer and Prasad (2010)	15	3–6 mm	9.7 mm	32	32	Wound dehiscence in 2 pts.
Korpi (2012)	22	<6 mm	4–10 mm	88	86	Mental nerve paresthesia in 2 pts.
Korpi (2013)	4	<10 mm	7.5 ± 1.7 mm	15	15	2 patients had difficulty in retention of prosthesis.
Kuoppala (2013)	17	NA	NA	67	65; 2 lost	Short term mental nerve paresthesia; pain at graft donor site.

was loosening of attachment component which occurred in 7 cases. Moderate mucosal hyperplasia around the implants was recorded in 9 patients. Radiographs revealed only minimal bone resorption around the implants. The patients oral health related profile was found to be good after treatment.²⁶

Korpi, Kainulainen, Sandor, Oikarinen (2013) published a preliminary case series in patients with severely atrophic fractured mandible treated with tentpole approach using immediate or delayed protocols. Four consecutive patients (2 male and 2 female; age 52–64 years) who satisfied the criteria of fractured, severely resorbed mandible of less than 10 mm vertical height were included. They were treated by modified tentpole technique using either of 2 protocols.

In first protocol, immediate tentpole technique with bone grafts harvested from posterior iliac crest placed immediately was the primary treatment. In the second protocol, initial treatment of fracture was done with ORIF followed by fracture hardware removal 6 months later and a delayed tentpole procedure was used to place the dental implants to anterior mandible with bone graft harvested from posterior iliac crest. The mean follow up was 19.8 months.

The recovery was uneventful in both protocols. The mean post op gain in alveolar ridge augmentation height was 7.5 ± 1.17 mm. Post op OPG confirmed the fixation of fractured mandible, placement of bone grafts and correct angulations of dental implants in immediate and delayed tentpole groups. There were 15 implant fixtures placed in 4 patients of which no implant fixture failure was seen in immediate or delayed protocol group. There was no bone resorption around any of the endosseous dental implants in either group on follow up.²⁷

Comparison of different studies based on soft tissue matrix expansion technique is cited in Table 1.

5. Conclusion

Thus it can be concluded that tentpole procedure is an effective technique for treatment in patients with large vertical defects. This technique involves expanding the soft tissue volume and prevents contraction of soft tissue matrix around the graft, subsequently preventing graft from displacement or physiological resorption. Thus a stable increase in vertical bone height is achieved by this tentpole procedure.

Conflicts of interest

All authors have none to declare.

REFERENCES

1. de Wijs FL, Cune MS. Immediate labial contour restoration for improved esthetic: a radiographic study on bone splitting in anterior single-tooth replacement. *Int J Oral Maxillofac Implant.* 1997;12:686–696.
2. Cawood JI, Howell RA. A classification of the edentulous jaws. *Int J Oral Maxillofac Surg.* 1988;17:232–236.
3. Gaggli A, Rainer H, Chiari FM. Horizontal distraction of the anterior maxilla in combination with bilateral sinus lift

- operation—preliminary report. *Int J Oral Maxillofac Surg*. 2005;34:37–44.
4. Rachmiel A, Srouji S, Peled M. Alveolar ridge augmentation by distraction osteogenesis. *Int J Oral Maxillofac Surg*. 2001;30:510–517.
 5. Zakhary IE, El-Mekkawi HA, Elsalanty ME. Alveolar ridge augmentation for implant fixation: status review. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2012 Nov;114(5 suppl 1): S179–S189. <http://dx.doi.org/10.1016/j.oooo.2011.09.031>. Epub 2012 May 12. Review. PubMed PMID: 23063396.
 6. Atwood DA. Postextraction changes in the adult mandible as illustrated by microradiographs of midsagittal sections and serial cephalometric roentgenograms. *J Prosthet Dent*. 1963;13:810–824.
 7. Juodzbalsys G, Raustia AM. Accuracy of clinical and radiological classification of the jawbone anatomy for implantation—a survey of 374 patients. *J Oral Implantol*. 2004;31:30–39.
 8. Jaffin RA, Berman CL. The excessive loss of Branemark fixtures in type IV bone: a 5-year analysis. *J Periodontol*. 1991;62:2–4.
 9. Davo R, Malevez C, Rojas J. Immediate function in the atrophic maxilla using zygoma implants: a preliminary study. *J Prosthet Dent*. 2007;97(6 suppl 1):S44–S51.
 10. Sjöström M, Sennerby L, Nilson H, Lundgren S. Reconstruction of the atrophic edentulous maxilla with free iliac crest grafts and implants: a 3-year report of a prospective clinical study. *Clin Implant Dent Relat Res*. 2007;9:46–59.
 11. Cawood JI, Howell RA. Reconstructive preprosthetic surgery. I. Anatomical considerations. *Int J Oral Maxillofac Surg*. 1991;20:75–82.
 12. McAllister BS, Haghighat K. Bone augmentation techniques. *J Periodontol*. 2007;78:377–396.
 13. Chackartchi T, Stabholz A. Ridge preservation after tooth extraction: what do we know today. *Refaat Hapeh Vehashinayim*. 2013 Apr;30:65–75, 83. Review. Hebrew. PubMed PMID: 24020248.
 14. Apaydin A, Yazdirduyev B, Can T, Keklikoglu N. Soft tissue changes during distraction osteogenesis. *Int J Oral Maxillofac Surg*. 2011 Apr;40:408–412. <http://dx.doi.org/10.1016/j.ijom.2010.11.007>. Epub 2010 Dec 30. PubMed PMID: 21195586.
 15. Alveolar Ridge augmentation with titanium mesh. A retrospective clinical study. *Open Dent J*. 2014;8:148–158. <http://dx.doi.org/10.2174/1874210601408010148>. Published online Sep 29, 2014.
 16. Proussaefs P, Lozada J. Use of titanium mesh for staged localized alveolar ridge augmentation: clinical and histologic-histomorphometric evaluation. *J Oral Implantol*. 2006;32:237–247. PubMed PMID: 17069168.
 17. Pieri F, Corinaldesi G, Fini M, Aldini NN, Giardino R, Marchetti C. Alveolar ridge augmentation with titanium mesh and a combination of autogenous bone and anorganic bovine bone: a 2-year prospective study. *J Periodontol*. 2008 Nov;79:2093–2103. <http://dx.doi.org/10.1902/jop.2008.080061>. PubMed PMID: 18980518.
 18. Rocuzzo M, Ramieri G, Spada MC, Bianchi SD, Berrone S. Vertical alveolar ridge augmentation by means of a titanium mesh and autogenous bone grafts. *Clin Oral Implants Res*. 2004 Feb;15:73–81. PubMed PMID: 14731180.
 19. Marx RE, Shellenberger T, Wimsatt J, Correa P. Severely resorbed mandible: predictable reconstruction with soft tissue matrix expansion (tent pole) grafts. *J Oral Maxillofac Surg*. 2002 Aug;60:878–888. discussion 888–9. PubMed PMID: 12149731.
 20. Fenton CC, Nish IA, Carmichael RP, Sándor GK. Metastatic mandibular retinoblastoma in a child reconstructed with soft tissue matrix expansion grafting: a preliminary report. *J Oral Maxillofac Surg*. 2007 Nov;65:2329–2335. PubMed PMID: 17954334.
 21. Manfro R, Batassini F, Bortoluzzi MC. Severely resorbed mandible treated by soft tissue matrix expansion (tent pole) grafts: case report. *Implant Dent*. 2008 Dec;17:408–413. <http://dx.doi.org/10.1097/ID.0b013e31818c6ba5>. PubMed PMID: 19077578.
 22. Le B, Burstein J, Sedghizadeh PP. Cortical tenting grafting technique in the severely atrophic alveolar ridge for implant site preparation. *Implant Dent*. 2008 Mar;17:40–50. <http://dx.doi.org/10.1097/ID.0b013e318166d503>. PubMed PMID: 18332757.
 23. Wannfors K, Johansson C, Donath K. Augmentation of the mandible via a “tent-pole” procedure and implant treatment in a patient with type III osteogenesis imperfecta: clinical and histologic considerations. *Int J Oral Maxillofac Implants*. 2009 Nov-Dec;24:1144–1148. PubMed PMID: 20162121.
 24. Le B, Rohrer MD, Prasad HS. Screw “tent-pole” grafting technique for reconstruction of large vertical alveolar ridge defects using human mineralized allograft for implant site preparation. *J Oral Maxillofac Surg*. 2010 Feb;68:428–435. <http://dx.doi.org/10.1016/j.joms.2009.04.059>. Epub 2010 Jan 15. Erratum in: *J Oral Maxillofac Surg*. 2010 Apr; 68:953. Prasad, Hari S. PubMed PMID: 20116718.
 25. Korpi JT, Kainulainen VT, Sándor GK, Oikarinen KS. Long-term follow-up of severely resorbed mandibles reconstructed using tent pole technique without platelet-rich plasma. *J Oral Maxillofac Surg*. 2012 Nov;70:2543–2548. <http://dx.doi.org/10.1016/j.joms.2012.07.027>. Epub 2012 Aug 22. PubMed PMID: 22921752.
 26. Kuoppala R, Kainulainen VT, Korpi JT, Sándor GK, Oikarinen KS, Raustia A. Outcome of treatment of implant-retained overdenture in patients with extreme mandibular bone resorption treated with bone grafts using a modified tent pole technique. *J Oral Maxillofac Surg*. 2013 Nov;71:1843–1851. <http://dx.doi.org/10.1016/j.joms.2013.06.204>. Epub 2013 Aug 14. PubMed PMID: 23953628.
 27. Korpi JT, Kainulainen VT, Sándor GK, Oikarinen KS. Tent-pole approach to treat severely atrophic fractured mandibles using immediate or delayed protocols: preliminary case series. *J Oral Maxillofac Surg*. 2013 Jan;71:83–89. <http://dx.doi.org/10.1016/j.joms.2012.09.008>. Epub 2012 Oct 23. PubMed PMID: 23099225.