

# Changes in Alveolar Bone Width Following Bone Expansion

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## Abstract

The placement of implants in edentulous areas is often compromised because of atrophic alveolar ridges. Several techniques have been suggested in the literature to increase inadequate bone width which includes bone grafting, distraction osteogenesis and bone expansion. Bone expansion technique is one of the most widely used methods which can also be utilized to increase the width of alveolar ridge and to provide sufficient bone volume for implant placement. The purpose of this study, is to measure the increase of the width of alveolar ridge after bone expansion following implant placement. Between 2013-2016, 30 consecutive, healthy, non-smoking, adult patients with atrophy of the maxilla and mandibula had 149 implants inserted. There were 18 women and 12 men, mean age 51.34 years (range 34 - 67). The initial width of the alveolar ridge measured from 2.5 to 3 mm (mean  $2.83 \pm 0.2$ ) with Cone beam computed tomography (CBCT). The mean increase of bone width was achieved 1.25 mm (between 0.64 mm and 1.73 mm). Before prosthetic rehabilitation, width of expanded alveolar bone was calculated from 3.50 to 4.75 mm with CBCT. During follow-up, 140 implants survived and 9 implants failed. The rate of implant survival was 93.95% after average 5 years follow-up. In conclusion, we suggest that, bone expansion is useful for managing the insufficient ridges for implant placement.

## Keywords

Inadequate Bone, Expansion, Dental Implant

## 1. Introduction

After tooth loss, histological and morphological changes of alveolar socket and adjacent soft tissue may undergo a series of tissue repair processes [1]. Implant treatment in alveolar ridge offers greater challenges of successful implant therapy depends on adequate bone quality and quantity [2]. However, inadequate

amount of bone for implant placement at functionally and esthetically most appropriate position is a common problem. Placement of implants in atrophic ridges is often accompanied by various challenges [1] [3]. If inadequate bone exists, several surgical techniques may be used to reconstruct the deficient ridge for implant placement [4].

Investigators have adopted several techniques to remedy these consequences [5] [6], including guided bone regeneration (GBR) [7], onlay grafts [8], distraction osteogenesis [9], ridge expansion [10], and revascularized flaps [6]. The bone manipulation techniques are capable of manipulating the one's bones to alter their density to make them extremely durable and strong. These techniques mobilize vital bone with plastic bending, shaping, or condensation of tissue as a bone flap or bone-periosteal flap [11].

A multidimensional assessment of the available bone is the most important factor necessary for a sound treatment planning ensuring longevity and function of implant supported prosthesis. Determinants of available bone are: Height, Width, Length, Angle, Crown/implant ratio [12]. Cone beam Computerized tomography (CBCT) was introduced to the dental field to replace expensive and high-radiation-producing medical CT scans around twenty years ago [13].

We aimed to evaluate of bone width using CBCT in the pre-operatively assigned bone site for implant placement and bone around implants placed in the same designated site using drilling technique and bone expansion with splitting osteotomy postoperatively. It evaluates pre- and postoperative bone width around implants using CBCT scan in expanded bones.

## **2. Material and Method**

### **2.1. Patient Selection**

A clinical study was conducted on patients who reported during year 2013-2016 to the Department of Oral and Maxillofacial Surgery, Istanbul University. A total of 30 patients, mean age = 51.34; range = 34 - 67, female = 18, male = 12, with inadequate alveolar width were included in the study. Hygiene conscious, motivated and willing to participate and gave written informed consent and those having adequate vertical height were included in the study. Patients with severe atrophic ridges, those with co-existing vertical defect requiring additional corrective intervention, heavy tobacco users, systemic contraindications to surgery, including severe renal or liver disease, uncontrolled diabetics, insufficient bone height for placement of implants at least 10 mm long, and active periodontal disease involving the adjacent teeth immunocompromised patients and those who were poorly motivated and unable to keep the follow-up were excluded from the study. All patients were given an oral explanation and detailed informed consent form was signed by patient according to the Helsinki declaration).

### **2.2. Measurement of Alveolar Bone Width**

Patients who presented with partial or total edentulous space in maxilla and

mandibula, having a ridge width of 2.5 mm to 6.0 mm, measured pre- and post-operatively, using CBCT (PaX-i3D®, VATEch Global, Gyeonggi-do, Korea) (**Figure 1**, **Figure 2**).

### 2.3. Surgical Procedures and Modified Splitting Osteotomy

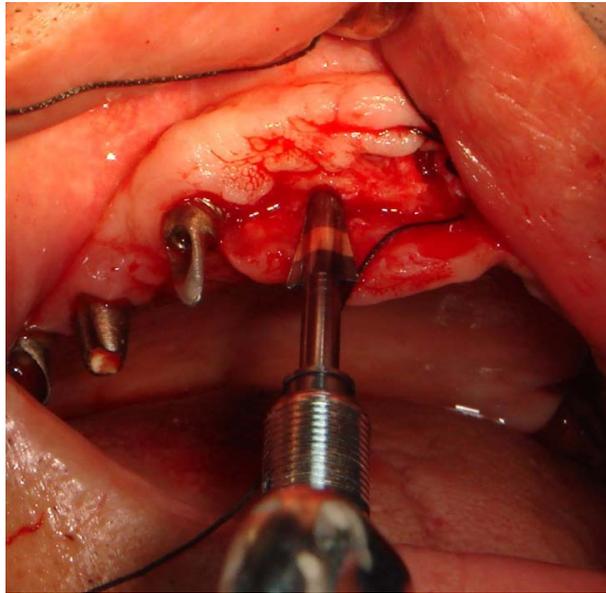
All surgical procedures were performed under aseptic conditions and following standard protocols. The baseline clinical examination consisted of a thorough medical and dental history, general and oral health status, assessment of future implant site. The available vertical, mesio-distal and labio-lingual bone dimension was determined by measurements from CBCT. The modified splitting osteotomy was done using osteotomes with mallets (Scwert®, Seitingen/Oberflacht, Germany) and magic split (Magic Drill Kit®, IBS Implant®, Daejeon, Korea) (**Figure 3**). After maintained sufficient bone and the ridge was achieved, 3, 3.5 or 4 mm wide and 10 to 13 mm high implants were placed into the prepared site under local anesthesia (IBS Implant®, Daejeon, Korea, Implant Direct® Thousand Oaks, CA, USA) (**Figure 4**). After implant placement, to



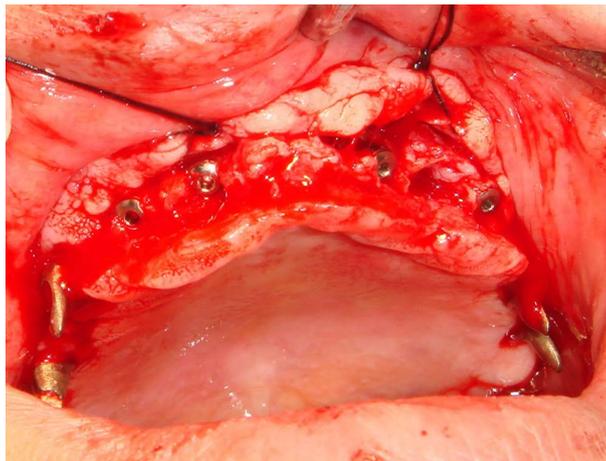
**Figure 1.** The measurement of alveolar ridge width on the cross-sectional CBCT image before the implant placement (62 y. female patient).



**Figure 2.** The measurement of alveolar ridge width on the cross-sectional CBCT image 8 months after the implant placement (62 y. female patient).

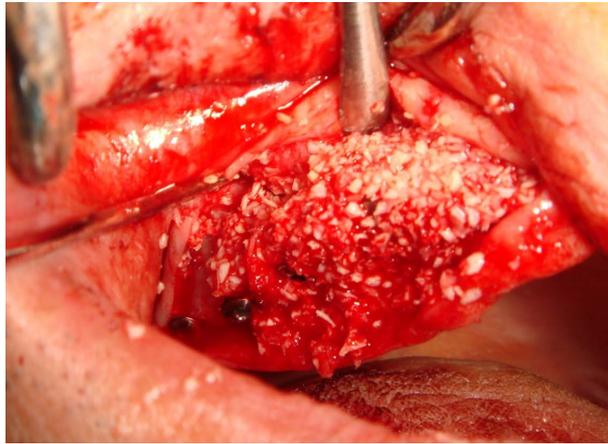


**Figure 3.** The preparation of the implant place with magic split ((Magic Drill Kit®, IBS Implant system, Daejeon, Korea) (59 y. male patient).

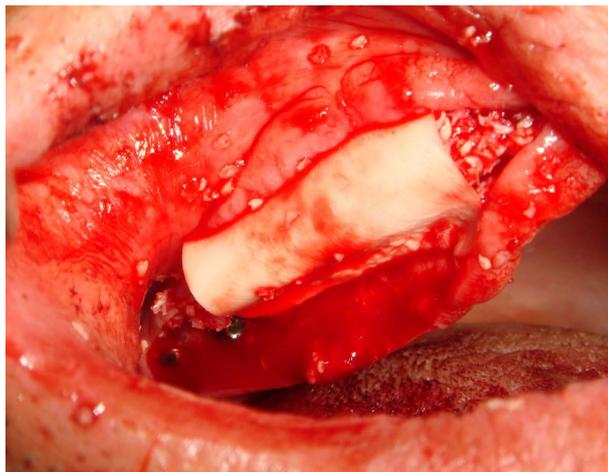


**Figure 4.** The placement of the implant after bone expansion (59 y. male patient).

increase bone density around the implants allografts (Corticocancellous graft, Maxxeus® Dental, OH, USA) and membrane (Collagene AT®, Centro di Odontoiatria Operativa S.r.l., Padova, Italy) were placed for guided bone regeneration (**Figure 5**, **Figure 6**). The reflected mucoperiosteal flaps were re-approximated and sutured around implants with a sling suture to achieve a good seal, creating a tenting effect over the allograft and membrane sutured with using silk suture material (**Figure 7**). All implants were positioned by the same surgeon. All implants were placed on the same day as the bone was expanded. Sutures were removed 7 - 10 days postoperatively. All patients were given amoxicillin 1 g orally twice a day starting the day before operation and continuing for 5 days. Postoperative care consisted of rinsing with 0.2% chlor-



**Figure 5.** The placement of the allograft (Corticocancellous graft, Maxxeus® Dental, OH, USA) (59 y. male patient).



**Figure 6.** The placement of the membrane (Collagene AT®, Centro di Odontoiatria Operativa S.r.l., Padova, Italy) (59 y. male patient).



**Figure 7.** The primer on sutures for wound closure.

hexidine twice daily for 10 days, and a soft diet. Non-steroidal analgesics were prescribed as needed for pain control. Three to four months after placement of the implants, abutments were connected and prosthetic rehabilitation begun. Before prosthetic rehabilitation, expanded bone width measurement was done with CBCT. Prosthetic rehabilitation was achieved for all patients (Figure 8) and followed-up during 5 years.

### 3. Results

Between 2013-2016, 30 consecutive, healthy, non-smoking, adult patients with atrophy of the alveolar bone had 149 implants (107 (71.81%) were in maxilla, 42 (28.19%) were in mandible) inserted. There were 18 women and 12 men, mean age 51.34 years (range 34 - 67).

The initial width of the alveolar ridge measured from 2.5 to 5 mm (mean  $2.83 \pm 0.2$ ) with CBCT. The mean increase of bone width was achieved 1.25 mm (between 0.64 mm and 1.73 mm). Before prosthetic rehabilitation, width of expanded alveolar bone was calculated from 3.50 to 5.95 mm with CBCT. During follow-up, 103 implants (96.26%) were survived and 4 (3.74%) implants were failed in maxilla. 37 implants (88.09%) were survived and 5 implants (11.91%) were failed in mandible. (Table 1). The total rate of implant survival was 93.95% after average 5 years follow-up. No infection was noted during the postoperative period and healing was uneventful.

### 4. Discussion

Bone expansion technique is defined as the manipulation of the bone to form a



Figure 8. The prosthetic rehabilitation.

Table 1. Distribution of inserted implants (n = 149).

Situation of implants	Maxilla	Mandible
Survived	103 (96.26%)	37 (88.09%)
Failed	4 (3.74%)	5 (11.91%)
Total	107 (71.81%)	42 (28.19%)

receptor site for an implant without the removal of any bone from the patient [14]. The objective is to maintain the existing soft bone by pushing the buccal bony plates of the residual ridge laterally with minimal trauma. This technique takes the advantage of the softer bone quality found in Types III and IV bone by relocating the alveolar bone rather than losing the precious bone by drilling [15]. In the present study we performed bone expansion with splitting osteotomy. Ridge expansions have been used to expand narrow alveolar ridges, however maxillary expansions were successful then mandibular expansions. The purpose of this study was to evaluate the efficacy of ridge gain by ridge expansion.

These result in contour or dimensional changes, while preserving bone integrity and viability. The concept is to manipulate the residual bone to create an intrabony cavity with a wider base or taller roof that heals like an extraction site, with access of mesenchymal stem cells and the normal wound healing mechanisms. The morphology of bony defect is an important consideration in the selection of a method for ridge manipulation. The fewer the number of remaining bony walls, the greater is the need for osteopromotive techniques [4].

The minimum implant length an ideal bone density situation is 10 mm. Allowing a margin of 2 mm from the vital landmarks such as inferior alveolar canal is recommended. Favorable width is defined as the distance between the buccal and the lingual plates, measured at the crest. Each 1 mm increase in diameter increases the surface area by about 20% - 30%, thus, increasing diameter effectively; decreases crestal stress. Therefore, implant diameter is much more critical than its length [4]. After bone expansion, 3, 3.5 or 4 mm wide and 10 to 13 mm high implants were placed into the prepared site in the present study.

In cases of advanced bone loss, there is insufficient bone width for rehabilitation with implants, and other alternatives for bone increase must be considered [16] [17] [18]. In some patients, the use of narrow implants can solve some cases, but when the bone width is 3 mm or less it is not feasible to contemplate the safe and stable installation of dental implants [19]. In the present study, because of efficacy of bone expansion, there was no used narrow implants.

The use of CBCT, which is more objective and reliable, for the assessment of the bone width of the patients requiring implant therapy was introduced [20], and this method has been in utilized several studies [21]. CBCT used before and after bone expansion measurement in the study. Implants that did not cause any problems during 5 months of osseointegration were considered successful and the bone density was not measured to the prosthetic rehabilitation regardless of the bone density.

The placement of implants in edentulous areas is often compromised because of atrophic alveolar ridges. Several techniques have been suggested in the literature to increase inadequate bone width which includes bone grafting, distraction osteogenesis and bone expansion. Bone expansion technique is one of the most used methods which can also be utilized to increase the width of

alveolar ridge and to provide sufficient bone volume for implant placement. More noninvasive technique of ridge splitting and expansion can be carried out easily, without much trauma to the patient. In conclusion, we suggest that, bone expansion technique is useful for managing the insufficient ridges for implant placement especially in maxilla.

### Fund

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