



Insufficient mandibular Alveolar ridge expansion for Dental Implant Placement: Ossiodensification vs. Ridge Splitting techniques

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KEYWORDS

Narrow Alveolar,
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surgery, Platelet rich in growth
factors (PRGF), Dental Implant.

ABSTRACT

Aim: To assess Narrow Alveolar Ridge Expansion by Ossiodensification vs. Ridge Splitting Techniques for Dental Implant Placement. **Subjects and methods:** Twenty patients were included in our study with narrow ridge width of 3-6 mm at crestal bone level. They were divided into two groups: Group I Osseodensification technique, Group II Ridge splitting technique with bone expanders and sticky bone augmentation with immediate implant placement in both groups. With assessment of implant stability (ISQ), and bone density in CBCT. **Results** Group I had showed statistically significant increase in mean bone density postoperative, after 3, 6 and 9 months ($p < 0.001$). Group II had showed statistically significant increase in mean bone density postoperative, after 3, 6 and 9 months ($p < 0.001$). Group II was 72.70 ± 4.55 that showed statistically significant increase in mean ISQ reading after 6 and 9 months ($p < 0.001$). **Conclusion:** Osseodensification was demonstrated higher implant primary stability and bone density around dental implants without bone sacrificially.

INTRODUCTION

Bone loss was an ongoing process following missing teeth affecting mandible four times more than maxilla⁽¹⁾. Thin alveolar ridge was a frequently encountered barrier to standard implant placement, pattern of bone resorption after tooth extraction was well known. Over a period of 4 to 12 months following tooth extraction. Buccolingual crestal bone dimension decreases by 3.1 to 5.9 mm (approximately 50% of original bone width). Changes in horizontal dimension were more pronounced in molar than premolar regions and were even more distinct in mandible than maxilla. ⁽²⁾

There was a consensus that a minimum of 6 to 7 mm of bone width was required for placement of an implant with a diameter of 3.5 up to 4 mm using a standard surgical protocol. Minimum bone width of 1 to 1.5 mm was required on both buccal and lingual sides for a predictable outcome. ⁽³⁾

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Resorbed ridges give a challenge in ways to add hard and soft tissue in defective sites to provide adequate height and width for appropriate implant insertion. To resolve this situation, alveolar ridge augmentation had been performed by many methods; Guided bone regeneration, Distraction osteogenesis, Onlay block grafting and Ridge splitting.⁽⁴⁾

Guided bone regeneration (GBR) was a well-documented procedure that has been successfully used for atrophic alveolar ridge augmentations.⁽⁵⁾ However, relatively long healing time and risk of membrane exposure that could result in bone loss or implant failure were the major limitations of this technique.⁽⁶⁾ Autogenous bone grafts harvested from intraoral or extraoral sites were predictable alternatives.⁽⁷⁾ Nevertheless, bone grafting procedures were associated with inconveniences related to donor site morbidity, long healing time before implant placement and bone graft resorption.⁽⁸⁾ Compared with guided bone regeneration or bone grafting, ridge splitting technique enables simultaneous implant placement, eliminates the need for bone harvesting and reduces risk of graft or membrane exposure. Therefore, overall treatment time was shortened, and morbidity was reduced.^(9,10)

Recently a new non-subtractive drilling technique, osseodensification (OD), was introduced where a specially designed drills rotate in a counterclockwise direction compacting bone at the osteotomy walls allowing more intimate engagement of implant with osteotomy site and increasing primary stability.⁽¹¹⁾ Maintaining and preserving bone during osteotomy preparation leads to increased primary mechanical stability that leads to increased bone to implant contact, which then enhances implant secondary stability, and accelerates healing process due to bone matrix cells, and biochemicals that were maintained in situ and autografted along the surface of osteotomy site.⁽¹²⁾

The aim of this study was to evaluate mandibular alveolar ridge expansion by osseodensification versus ridge splitting technique with bone expanders and sticky bone augmentation supplemented by

immediate implant placement in both groups.

PATIENTS AND METHOD

This study was designed as a randomized clinical trial of 30 implants over 20 patients with missing mandibular posterior teeth seeking for receiving dental implants. They were selected from Outpatient clinic of Oral and Maxillofacial Surgery Department, Faculty of Dental Medicine, Al-Azhar University, Assiut Branch.

Inclusion criteria

1. Patient's age was ≥ 18 years old including both genders.
2. Healed long span edentulous area was selected in mandible for at least 6 months after extraction.
3. Patients who had an alveolar ridge with sufficient horizontal dimensions 3-6 mm width bucco-lingually and vertical dimensions were minimum of 10 mm height.
4. Mandibular posterior regions with low bone density (D3-D4 bone density according to Misch's bone classification)⁽¹³⁾ based on CBCT findings.

Exclusion criteria

1. Presence of acute or chronic infection or local pathological condition at proposed implant zone.
2. Mandibular posterior regions with high bone density (D1 and D2 bone density according to Misch bone classification)⁽¹³⁾ depending on CBCT findings.
3. Patients with parafunctional habits such as severe bruxism and clenching.
4. Any local limitation that interfere with implant placement like inadequate inter-ridge distance or insufficient vertical height.
5. Any drug that compromise healing of bone like corticosteroids, contraceptive pills, or Bisphosphonates.



6. Patients with history of any uncontrolled systemic disease or local condition that compromises bone healing potential.
7. History of radiotherapy to head and neck region or chemotherapy over past 5 years.

Grouping

Group (I), 10 patients with partial edentulous narrow mandibular ridges were treated by piezosurgery horizontal crestal cut with no vertical cuts, supplemented by osseodensification technique with simultaneous implant placement into their ridges.

Group (II), 10 patients with partial edentulous narrow mandibular ridges were treated by piezosurgery ridge splitting technique as horizontal crestal cut with two vertical cuts and serial hand bone expanders then implant placement into their ridges supplemented by sticky bone and membrane coverage.

Assessment:

- **Clinical parameters**
 - ISQ reading
- **Radiographic parameters**
 - Bone density

Follow up and data collection

I. Clinical parameters

Implant stability quotient (ISQ):

All implants were evaluated for primary stability once after implant insertion with an Osstell® a magnetic resonance device, which used resonance frequency analysis for determining implant stability and another measurement after six months at second surgical phase.

A high value indicated greater stability, whereas a low value implied instability. Smart peg was screwed simply into implant, handheld probe simulates the smart peg magnetically, without being connected or even touching it.

II. Radiographic parameters

Measuring of bone density:

By using of BlueSky Bio (software), change in bone density around implant was calculated in Hounsfield units (HU). The positions of measurement sites were located at the top, middle and apical part of implant on buccal, lingual, mesial and distal sides. Thickness of slices was constant in all examinations. Mean values of bone density along each side of implant were recorded and average density was determined. This process was repeated at each interval of postoperative follow up (immediate, 3, 6 and 9) months.

Prosthetic phase:

Six months after implant placement, second surgical exposure to fixture then gingival formers was inserted for 1-2 weeks to provide appropriate gingival contour at implant's collar area. Impression was taken using open tray impression technique with implant impression coupling and implant analogues. Porcelain fuse to metal screw retained crowns were delivered to all patients for both groups and abutments were connected to the implants with a torque of 35 N/cm, and implants were functionally loaded. Patients were instructed about the maintenance of oral hygiene by means of dental floss, interdental brush, and mouth wash.

Statistical analysis of the data:

Data were fed to computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) Qualitative data were described using number and percent. The Shapiro-Wilk test was used to verify normality of distribution. Quantitative data were described using range (minimum and maximum), mean, standard deviation and median. Significance of obtained results was judged at the 5% level. The used tests were 1 - Chi-square test for categorical variables, to compare between different groups. 2 - Fisher's Exact correction for chi-square when more than 20% of the cells have expected count less than 5. 3 - Student t-test for normally distributed quantitative

variables, to compare between two studied groups. 4 - ANOVA with repeated measures for normally distributed quantitative variables, to compare

between more than two periods or stages, and Post Hoc test (Bonferroni adjusted) for pairwise comparisons.

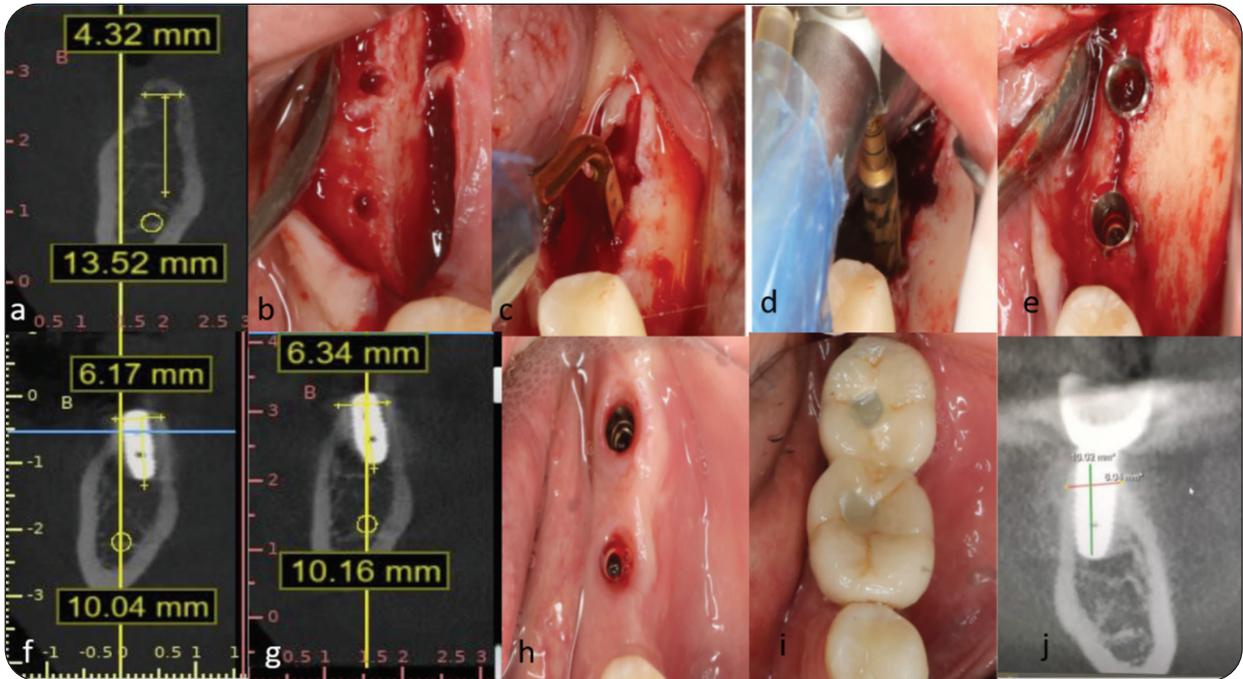


Fig. (1) a: Initial widths and lengths of alveolar ridge, b: Pilot drill osteotomy, c: Horizontal crestal ridge cutting with Piezosurgery, d: Osseodensification drill at implant site., e: Implant in desired site, f: Bone widths and lengths of alveolar bone 3 months postoperatively, g: Bone widths and lengths of alveolar 6 months postoperatively, h: Healing abutment removal, I: Porcelain fused to metal bridge delivery, j: Bone widths and lengths of alveolar bone 9 months postoperatively.

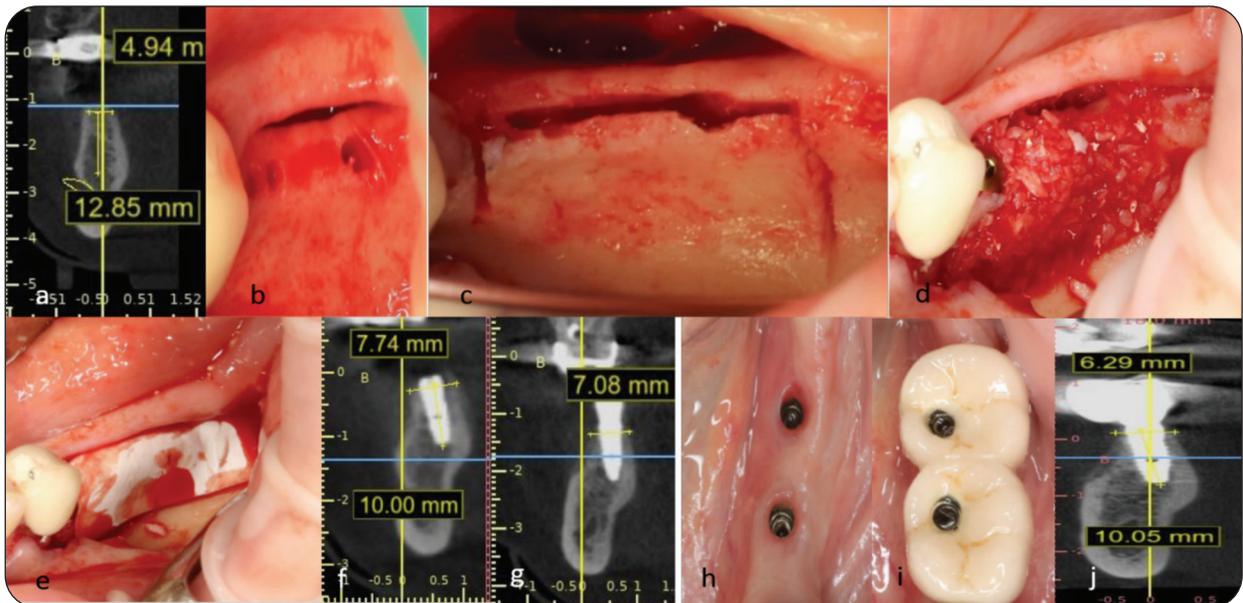


Fig. (2) a: Initial widths and lengths of alveolar ridge, b: Pilot drill osteotomy, c: Horizontal crestal ridge cutting with Piezosurgery, d: Sticky bone in place, e: Collagen membrane over sticky bone, f: Bone widths and lengths of alveolar bone 3 months postoperatively, g: Bone widths and lengths of alveolar bone 6 months postoperatively, h: Healing abutment removal, I: Porcelain fused to metal bridge delivery, g: Bone widths and lengths of alveolar bone 9 months postoperatively.

RESULTS

According to demographic data, ten patients ranged in age between 28.0 – 40.0 years with a mean age 34.80 ± 3.36 years for Ossiodensification group I and ten patients ranged in age between 28.0 – 42.0 years with a mean age of 35.0 ± 4.35 years for Ridge splitting group II. There was statistically non-significant difference between two groups regarding to the mean of age. Ridge splitting group II had 10 females, while Ossiodensification group I had 2 males and 8 females. There was statistically non-significant difference between gender distributions in two groups.

Regarding ISQ reading, Ossiodensification

Group (I) showed a statistically a significant higher ISQ reading than Ridge splitting Regarding Initial, and After 6 month. After 9 month, there was a statistically a non-significant difference between groups ($p=0.052$) Table (1).

Regarding Bone Density, Initial, Postoperative, After 3 month , After 6 month , After 9 month there was a statistically anon- significant difference between groups ($p=0.176, 0.792, 0.824, 0.721, 0.848$ respectively). Regarding Increase from Initial, there was a statistically a significant difference. Ossiodensification showed a higher Increase from Initial than Ridge splitting Postoperative and after 3 month (Table (1)).

Table (1) Comparison between the two studied groups according to ISQ reading and Bone Density

	Ossiodensification (n = 10)	Ridge splitting (n = 10)	t	p
Age (years)	34.80 ± 3.36	35.0 ± 4.35	$t= 0.115$	0.910
Sex				
Male	2 (20.0)	0 (0.0%)	$\chi^2= 2.222$	FEp= 0.474
Female	8 (80.0)	10 (100.0)		
ISQ reading				
Initial	73.70 ± 5.79	39.0 ± 6.15	12.991*	<0.001*
After 6 month	77.0 ± 6.06	70.90 ± 3.78	2.701*	0.015*
After 9 month	77.0 ± 4.69	72.70 ± 4.55	2.081	0.052
Bone Density				
Initial	408.8 ± 116.3	487.0 ± 131.2	1.410	0.176
Postoperative	682.0 ± 66.93	668.6 ± 142.1	0.270	0.792
After 3	766.2 ± 94.70	775.4 ± 87.26	0.226	0.824
After 6	853.5 ± 68.22	865.8 ± 82.90	0.362	0.721
After 9	806.8 ± 45.0	812.2 ± 75.52	0.194	0.848
Increase from Initial				
Postoperative	273.2 ± 69.0	181.6 ± 113.7	2.179*	0.043*
After 3	357.4 ± 58.50	288.4 ± 85.21	2.111*	0.049*
After 6	444.7 ± 66.57	378.8 ± 99.39	1.742	0.099
After 9	398.0 ± 99.97	325.2 ± 106.3	1.577	0.132

Data was expressed using Mean \pm SD.

t: Student t-test

p: p value for comparing between the two studied groups

*: Statistically significant at $p \leq 0.05$

DISCUSSION

In our present study we had evaluated mandibular alveolar ridge expansion by osseodensification versus ridge splitting techniques via bone expanders supplemented by sticky bone with platelet rich in growth factors and collagen membrane coverage. In our study, sufficient vertical height was required to splitting and implant placement and it was determined before surgery at least 10mm. This was in accordance with Abdullah & Dibart⁽¹⁴⁾ and Troedhan et al⁽¹⁵⁾ who had recommended that minimum alveolar crest-height had to be 11-12 mm to allow a vertical osteotomy of minimum 7-8 mm, avoiding excess of elastic properties of alveolar crest in distraction process, and insertion of implants 2-3 mm deeper than osteotomy into non-distracted crestal bone for achieving primary stability.

One major drawback of alveolar bone splitting was risk for bone resorption due to malnutrition of the laterally out displaced buccal bone wall⁽¹⁶⁾. In our current study using xenografts powder mixed with plasma rich in growth factor and calcium chloride to make sticky bone graft with a barrier membrane to achieve more bone width as it was statistically significant difference in ridge splitting showed a higher increase in bone gain in CBCT after 3, 6 and 9 months ($p < 0.001^*$). Platelets were known to release high quantities of growth factors, which stimulate cell proliferation, matrix remodeling, and angiogenesis.⁽¹⁷⁾ Sticky bone was biologically solidified bone graft which was entrapped in fibrin network. Sticky bone graft doesn't scatter even upon being shaken because particulate bone powders had strongly interconnected each other by fibrin network. Growth factors were to assist the body in repairing itself by stimulating stem cells to regenerate new tissues.⁽¹⁸⁾

In this study, resorbable collagen membranes was used to cover sticky bone graft. Collagen absorbable barrier membranes did not require surgical removal, inhibited migration of epithelial cells, promoted attachment of new connective tissue, were

not strongly antigenic and prevented blood loss by promoting platelet aggregation leading to early clot formation and wound stabilization.⁽¹⁹⁾ The main advantages of piezoelectric instrument were a precise and specific cut on mineralized tissues in both groups, as well as its capacity to cause minimal tissue damage resulting in improved healing.⁽²⁰⁾

In our study we had got a successful result with piezosurgery in crestal ridge splitting supplemented by immediate implant placement which agreed with Blus et al.⁽²¹⁾ who had been got a successful result using piezosurgery for ridge splitting and immediate implant insertion in mandible without any complications. Huwais's⁽¹²⁾ osseodensification drills were introduced with a specially designed shape which rotate in a counterclockwise direction compacting bone at osteotomy walls allowing more intimate engagement of implant with osteotomy site and increasing primary stability. This was in agreement with our result that showed a successful result in primary stability in group I than group II.

In our present study, osseodensification group I had showed a statistically significant difference at ISQ reading than ridge splitting group II intra operatively. After 6 months, there was slight statistically significant difference between groups ($p < 0.015^*$), where osseodensification group showed a statistically a significant higher in ISQ reading than ridge splitting group. After 9 months, there was a statistically non-significant difference between two groups ($p = 0.052$). Osseodensification group was shown to enhance implant primary stability, due to compaction auto-grafting and the associated spring-back effect⁽²⁷⁾; increasing bone-to-implant contact (BIC) upon implant placement. These autografted bone particles in trabecular spaces acted as core for faster bone formation around implant, potentially shortened healing time.⁽²²⁾

In this study osseodensification group I had showed statistically significant increase in mean bone density postoperative periods 3, 6 and 9 months ($p < 0.001$). Huwais and Meyer⁽¹²⁾ had got



similar results in their animal study that demonstrated increased mineral bone density around the periphery of osteotomy and produced a compaction autografted bone along the entire depth of osteotomy, especially at apical portion with osseodensification group. The same findings were also obtained by Huwais et al. ⁽²³⁾ in their 5-years retrospective clinical study that had demonstrated osseodensification technique enhanced bone density through compaction autografting and thus facilitated crestal sinus augmentation; however ridge splitting group II had showed statistically significant increase in mean bone density after 3, 6 and 9 months ($p < 0.001$).

In Comparison between two studied groups regarding bone density, we had observed that there was statistically non-significant difference between groups ($p = 0.369$) at initial reading. While after three months osseodensification group I had showed statistically significant difference than group II ($p = 0.001$) that denoted a higher bone density than ridge splitting group. This higher density had been increased after six months at osseodensification group I to reach ($p = 0.002$) that denoted a higher bone density than group II. At the end of nine months osseodensification group I had showed the best statistically significant difference ($p = 0.001$) than ridge splitting group II with best reading of bone density of two groups. This result may be explained due to high bone to implant contact in osseodensification group I and elasticity of cancellous bone, while in ridge splitting group II implant gained its primary stability from apical 2mm and the remaining part was surrounded by grafted bone mixed with growth factors and dynamic process that bone tissue modeling and remodeling. This was in agreement with Berglundh et al ⁽²⁴⁾ who had reported that physiologic drop of implant stability during early osseous healing period was associated with resorption of bone which was evident during first weeks of healing, the resorbed bone was replaced with newly formed viable bone that represented transition of the implant stability from mechanical anchorage responsible for primary stability to biological attachment responsible for secondary stability.

CONCLUSION

Implant survival rate in both groups had suggested that osseodensification and ridge splitting using bone expanders were a successful method for narrow alveolar bone expansion. Osseodensification was demonstrated to be able to increase primary stability and bone density around dental implants. Sticky bone with Platelet rich in growth factors had shown great enhancement of bone integration around the dental implant.

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الأزهر

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امتداد حافة الفك السفلى السنخية الغير كافية لوضع غرسة الالسنان : التكتيف العظمى مقابل تقنية شق الحافة

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الملخص :

الهدف: تقييم توسع الحيد السنخي الضيق عن طريق تكتيف العظم مقابل تقنيات شق الحيد لوضع زراعة الأسنان.

المواد والاساليب: تم تضمين عشرين مريضاً في دراستنا مع عرض ضيق من 3-6 ملم على مستوى العظام الكريستالية. تم تقسيمهم إلى مجموعتين: المجموعة الأولى تقنية تكتيف العظام. المجموعة الثانية تقنية تقسيم الحافة باستخدام موسعات العظام وتكبير العظام للزج مع وضع الزرع الفوري في كلا المجموعتين. مع تقييم ثبات الزرعة (ISQ) وكثافة العظام في CBCT.

النتائج: أظهرت نتائج المجموعة الأولى زيادة ذات دلالة إحصائية في متوسط كثافة العظام بعد العملية الجراحية. بعد 3 و 6 و 9 أشهر (P<0.001). أظهرت المجموعة الثانية زيادة ذات دلالة إحصائية في متوسط كثافة العظام بعد العملية الجراحية. بعد 3 و 6 و 9 أشهر (P<0.001). كانت المجموعة الثانية 72.70 ± 4.55 والتي أظهرت زيادة ذات دلالة إحصائية في متوسط قراءة ISQ بعد 6 و 9 أشهر (P<0.001).

الخلاصة: أظهرت عملية تكتيف العظام استقراراً أولياً أعلى للزرع وكثافة عظمية حول زراعة الأسنان بدون التضحية بعظام الفك.

الكلمات المفتاحية: حافة الفك الضيقة. تقنية تكتيف العظم. تقنية شق الحافة. جراحة بيزو. الصفائح الدموية الغنية بعوامل النمو. زراعة الأسنان