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Onlay Grafting V/S Ridge Split Technique For Managing Thin Ridges – A Surgeon's Dilemma

[1]Dr. Deepak S, MDS, Fellow and Diplomate (ICOI), Reader, Department of Oral and Maxillofacial Surgery, D A Pandu Memorial R V Dental College, Bangalore

[2]Dr. Sunil Vasudev, MDS, Professor and HOD, Department of Oral and Maxillofacial surgery, D A Pandu Memorial R V Dental College, Bangalore

[3]Dr.Sahana M S, MDS, Fellow (ICOI), Senior Lecturer, Department of Oral and Maxillofacial Surgery, D A Pandu Memorial R V Dental College, Bangalore

[4]Dr.Balavikhram K, MDS, MOMS RCPS, Reader, Department of Oral and Maxillofacial Surgery, D A Pandu Memorial R V Dental College, Bangalore

[5]Dr.Sarayu Gopal, MDS, Senior Lecturer, Department of Oral and Maxillofacial Surgery, D A Pandu Memorial R V Dental College, Bangalore

Corresponding Author: Dr. Deepak S, MDS, Fellow and Diplomate (ICOI), Reader, Department of Oral and Maxillofacial Surgery, D A Pandu Memorial R V Dental College, Bangalore

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Abstract

The use of dental implants in oral rehabilitation of partially and fully edentulous jaws have become a routine treatment modality with reliable long term results. Implant placement necessitates sufficient amount of width and depth of alveolar ridge. Common methods to restore bone deficiency include guided bone regeneration, ridge split and autogenous onlay bone grafts. Ridge split technique is performed to widen a narrow ridge to place adequate diameter implants. Onlay bone grafting is a procedure where a block of autogenous bone is secured at the bone defect area to regenerate bone at the host site.

The purpose of this study is to compare the feasibility and outcome of ridge split technique vs onlay bone grafting in implant prosthetic rehabilitation of knife edge ridges.

Objectives: To compare the post-operative pain and healing, intra-operative time, post- operative scarring crestal bone loss, using the above mentioned modalities.

Methods: Ten patient with long term edentulous region with knife edge ridges requiring implant prosthetic rehabilitation were selected for the entire research. The

samples were randomly distributed into ridge split group and onlay bone grafting group.

Results: (1) Intraopertive time and complete treatment time required was significantly higher in onlay bone grafting group. (2) Distribution of level of pain is slightly higher in onlay bone grafting group. (3) Final bone width gained is higher in onlay bone grafting group. (4) Crestal bone loss was significantly higher in onlay bone grafting group than that in ridge split group.

Interpretation & Conclusion: Bone resorption for onlay bone grafting technique was higher than for ridge split technique, but their implant survival rates were similar. Ridge splitting technique could shorten the treatment period, decrease postoperative pain and swelling and pain, eliminate the need for a second surgical site, and ease the patient cooperation to the surgery.

Keywords: Ridge split; onlay bone grafting; Implant; Bone loss.

Introduction

Dental implants in oral rehabilitation of partially and fully edentulous jaws have become a routine treatment modality in the last decade with reliable long term results. However, unfavorable local condition of the alveolar ridge due to atrophy, periodontal disease and trauma may produce insufficient bone volume or unfavorable vertical, horizontal and sagittal inter-maxillary relationship which may render implant placement impossible from a functional and esthetic viewpoint[1]. Implant placement necessitates sufficient width and height of the alveolar ridge. Common methods to restore bone deficiency include guided bone regeneration, ridge split and autogenous block bone grafts. Post extraction alveolar ridge resorption follows a predictable pattern from high well rounded to knife edged and low well rounded ridges.[2]

An edentulous ridge expansion or split crest technique for implant placement was originally described by Simeon et al and later on modified by Scipioni et al[3]. Ridge split technique is form of alveolar inlay osteoplasty that is usually performed in a closed fashion, uses a tactile sense and belongs to a category of minimally invasive intra-oral surgical technique [4]. This technique is performed to widen a narrow ridge to place adequate diameter implants. Alveolar ridge expansion also known as bone splitting technique represents the horizontal equivalent to vertical distraction or inter-positional grafting. The techniques splits the two cortical plates apart to achieve adequate bucco-lingual ridge dimensions for ideal diameter implant placement between two cortical plates. The residual gap created maybe filled with bone graft material but generally undergoes spontaneous ossification. The site is covered with resorbable collagen membrane and flap sutured back with primary closure. With recent advancements in implant science various modification have been made to conventional ridge split techniques and can selectively be performed in any particular case. Ridge split technique in cases of narrow alveolar ridges that has been widened in preparation of an implant placement tends to have a higher success rate and better buccal cortical bone preservation. Careful displacement of the buccal plate is essential when ridge splitting is used because abnormal bone healing may result from undue trauma to the cortical plates. Bone splitting presents the advantage of simultaneous implant placement. Alveolar ridge splitting has been described to achieve buccal displacement of the vestibular wall. This technique augments the width of the alveolar bone and creates space for the dental implants. There needs to be a minimal cortical thickness of 3mm together with trabecular bone between the cortical layers to perform

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alveolar ridge splitting[4-6]. Among alveolar ridge augmentation techniques the ridge split procedure demonstrate many benefits, including no need for a second surgical site, rare risk of inferior alveolar nerve injury and less pain and swelling.[6]

Onlay bone grafting is a procedure where a block of autogenous bone is secured at the bone defect area to regenerate bone at the host site. Autogenous bone can be used in several forms including cancellous marrow particulate bone chips, cortical and cortico-cancellous blocks. Osteocompetent mesenchymal cells are transformed into osteoblasts through osteoinduction. The graft is remodeled and replaced with new bone over time. Titanium screws are placed to fix bone block to the residual alveolar crest. Donor sites for free autogenous bone graft technique consist of extaoral sites which include iliac crest, calvarial bone, rib and tibia, intraoral sites include symphysis, ramus, zygomatic buttress and tuberosity of maxilla. The iliac crest graft is usually used for the large maxillofacial defects and often used for the full arch ridge reconstruction in implantology. Misch and associates et al first described the use of intra-oral sites such as mandibular symphysis and ramus to harvest bone blocks, which can be used for reconstruction of ridge defects. The intra-oral donor sites offers several advantage over extra-oral donor sites, including less discomfort, close proximity of donor and recipient sites, less cost, no hospitalization, capability to be performed under local anesthesia. Onlay bone grafts permit the recreation of a more favorable environment for implant placement. The major disadvantage of the onlay bone grafting technique is the need for secondary operative procedure.

Based on the above points it is worth that an investigation be carried out by comparing the two modalities. Hence we intended to compare the feasibility and outcome of ridge split technique versus onlay bone grafting in implant prosthetic rehabilitation of knife edge ridges.

Sample Size

A total of ten patients having long term edentulous region with knife edge ridges were included in this study. Out of ten patients five patients were treated by ridge split technique while the other five using onlay bone grafting.

Onlay Bone Grafting Technique

- The procedure was carried out under local anaesthesia using 2% lignocaine hydrochloride with 1:80000 adrenalines for the recipient site.
- The incision was made on the crest and interdental papilla down to the periosteum. Then the flap was detached towards the base of the jaw.
- Once the bone (edentulous ridge) was completely exposed, the alveolar ridge was clinically evaluated for the width and height required to decide the surgical technique and also the volume of bone graft required from donor site.
- Regional anesthesia using intra-oral nerve blocks with 2% lignocaine hydrochloride with 1:80000 adrenalines for the donor site was administered.
- The mucoperiosteal flap was elevated to expose the donor site.
- Once the bone was exposed a bone block of the desired shape was harvested by creating a bony window using straight fissure bur under copious amount of saline irrigation.
- The osteotomy was completed approximately 4 to 5 mm deep, depending on the thickness and defect area.

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- The chisel or levers were placed in the slot created by the osteotomy and the block was separated, this way obtaining the cortical and medullary grafts.
- The block graft is transported to the recipient sit and the bone block was fixed to the recipient site 2 titanium screw
- Mucoperiosteal flap repositioned and sutured using 3-0 vicryl at the donor site.
- The recipient site was left to heal for 4-6 months without any functional loading.
- After the healing period the grafted site is rexposed and fixation screws are removed.
- Pilot drills/ lanceting drills placed.
- Sequential osteotomies were made with ascending sizes of the osteotomy drills. Implant was inserted into the osteotomy site monitoring its direction and the primary stability using a wrench.
- Mucoperiosteal flap was repositioned and sutured using 3-0 vicryl

Ridge Spilt Technique.

- Local anaesthesia was achieved using intra-oral nerve blocks using 2% lignocaine hydrochloride with 1:80000 adrenaline and infiltration in the proposed surgical site.
- A full-thickness incision of the appropriate length was performed in the edentulous area at the crest of the ridge.
- The developed flap was limited crestal (not buccal) full-thickness flap just large enough to see the top of the alveolar crest.
- Alveolar ridge was split along the crest in a single-stage procedure using a fine straight fissure bur followed by splitting the ridge using a chisel and mallet.
- A greenstick separation of the deficient buccal cortical plate from the palatal portion of the alveolar bone, was carefully done, which lead to an opening of the bony gap with formation of a buccal vascular osteoperiosteal bone flap.
- Pilot drills/ lanceting drills were placed.
- Sequential osteotomies were made with ascending sizes of the osteotomy drills. Implant was inserted into the osteotomy site monitoring its direction and the primary stability using a wrench.
- Mucoperiosteal flap was repositioned and sutured using 3-0 vicryl.

Results were evaluated based on following parameters -

1. Intraoperative time for both the procedure.
2. Number of supplementary surgical procedures required for the Ridge split and Onlay bone graft procedure.

- Pain was evaluated on VAS scale

Statistical Analysis

The study data was analyzed using SPSS v.22 IBM, Corp. for Windows. A descriptive analysis of the data presented as frequency, mean, and standard deviation (SD) for the Visual Analogue Scale scores & Bone Loss. Student unpaired t test was used to compare the mean VAS Scores between 02 study groups at each time interval. Similar test was used to compare the mean density of bone to account for bone loss at the end of 6 months.

Repeated measures of ANOVA was used to compare the mean VAS scores between different time intervals for within subjects' variation in each of the study groups. . The level of significance was set at $P<0.05$.

Discussion

Rehabilitation of the edentulous jaws with dental implants is a predictable and satisfactory option; however, there are some obstacles due to the quantity and quality of the bone[7]. Implant placement necessitates

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sufficient amount of width and height of the alveolar ridge. There is a 25% decrease in volume during the first year and a 40% to 60% decrease in width within the first 3 years after tooth loss. Horizontal bone loss occurs faster and to a greater extent than vertical bone loss[8]. Common methods to restore horizontal deficiency include guided bone regeneration, ridge split and block bone grafts. Autogenous onlay bone grafting is considered to be the gold standard for reconstruction of jaw atrophy due to its osteoconductive, osteoinductive and osteogenic properties. Ridge splitting procedure, in selective cases can be preferred over onlaygrafting .Among alveolar ridge splitting technique the ridge split procedure demonstrates many benefits, including no need for a secondary surgical site, rare risk of alveolar nerve injury and less pain and swelling.

In this study, ten patients with edentulous knife edge ridges were randomly distributed into two groups of five patients each, ridge split group and onlay bone grafting group.

The onlay bone grafting procedure was performed in one site of 5 patients(3 female,2 male age range 20-42years with a mean age 30years).All five sites were in the maxillary anterior region .A total of 16 dental implants were placed in this group after 5to 6 months following bone augmentation. The alveolar ridge split was performed in only one site of 5 patients(2 male 3 female age range of 24-56 years, mean age 32 years)4 sites were in maxillary anterior region and one site was in mandibular anterior region .A total of 14 implants were placed in this group.

Autogenous onlay bone grafting is an advantageous technique for bone augmentation because of its osteoconductive and osteogenic properties, its ability to provide sufficient amount of bone volume required in the recipient site and biocompatibility. Autogenous bone is the only graft material with osteogenic potential that can directly form bone. The need for `donor site, surgical complication the need for delayed implant placement decreases the preference for this method .The use of iliac crest autogenous bone block with the osseointegrated implants was originally described by Branemark et al ,and has been extensively used for maxillofacial reconstruction procedures. Misch and associates et al, first described the use of intraoral sites such as mandibular symphysis and ramus to harvest bone blocks. The intra oral donor sites offer several advantages over the extraoral site including less discomfort, close proximity of donor and and recipient sites, less cost no hospitalization, capability to be performed under local anaesthesia. Clavero et al stated that access to symphysis region is easier than that of the ramus region; however, a greater amount of bone can be obtained with ramus graft. In our study population of five patients, we preferred to harvest bone block from the mandibular symphysis and iliac crest region. In four patient mandibular symphysis was used as the donor site and in one patient iliac crest was used as the donor site. We harvested onlay bone graft mainly from the mandibular symphysis region as there is lower risk nerve damage and better patient compliance. An edentulous ridge expansion or split crest technique for implant placement was originally described by scipioni et al.

Ridge split technique is a form of alveolar inlay osteoplasty that is usually performed in a closed fashion, uses a tactile sense and belongs to minimally invasiveintra oral surgical technique[9].This technique is performed to widen a narrow ridge to place adequate diameter implants. The main principle is the splitting and widening of the buccal plate anteriorly. The main advantage of .this technique is predictable amount of bone gain rapid vascularization leading to improved

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bone healing and bone remodeling similar to that on fracture healing.[10-11]. In a systemic review conducted by Milinkovic and colaradostated that the mean initial horizontal thickness where autogenous blocks were used was 3.2mm .The linear bone gain was 4.3mm after a healing time of approximately 5.6months.The mean width of reconstructed bone was 7.51mm.The mean width of alveolar bone where ridge splitting was performed was 3.37mm.This is an agreement to our study. In our study the mean final bone width gained by onlay bone grafting group was significantly higher than ridge split group. There was no statistically significant difference regarding implant diameter inserted in the two groups. The amount of bone resorption measured on cone beam computed tomography varied between .3to.5mm in ridge split group and .8mm to1.2 mm (mean.98mm) in the onlay bone grafting group. There was significantly more bone resorption in the onlay bone grafting group compared to alveolar ridge splitting group($p<0.001$).However final bone width gained was higher in onlay bone grafting group. Penaracho-Diago[10] et al conducted a study on 42 patients having 71 implants (33delayed and 38 simultaneously inserted) following horizontal ridge augmentation, they concluded that both protocols resulted in high implant survival and success rates, but marginal bone loss was more in simultaneous group. In our study we inserted implants between 6-7 months following augmentation to achieve good primary stability of implant.

Our study population consisted of 10 patients presenting with prosthetic rehabilitation of knife edge ridges. Ridge split technique was used for implant prosthetic rehabilitation in one group of five patients and onlay bone grafting was used for another group of five patients. Onlay bone grafting was more time consuming ranging from 40-48 minutes(mean 46.4)when compared to ridge splitting which ranged from 20-24minutes(mean 21.8).There was statistically highly significant difference between intraoperative time among group 1 and group 2 study subject.

It was found that ridge splitting demonstrates several advantages including less operative time, good intra-operative hemostasis, less pain and swelling. Time required for complete treatment was more in onlay bone grafting which ranged from 290-308days(mean 300.6)when compared to ridge splitting which ranged from 105-115days(mean110).There was statistically highly significant difference between complete treatment time. It was found that ridge split offers the advantage of simultaneous implant placement and requires less treatment time. Post- operative pain was slightly more in onlay bone grafting group than ridge split group on 2ndday, however it was similar in both the group on 1 month follow up.

Surgical complication is an important factor to consider, in addition to several others, including the amount of bone required type of bone (cortical or cancellous or both), morphology of the recipient site, and resorption of the bone graft, during bone harvesting[12-13]. Complications related to Onlay bone grafting may originate from either donor or recipient site. Temporary exposure of graft ,sensory disturbance are the most common complication. Other complications include wound dehiscence, infection, graft loss, paresthesia and post-operative scarring at the donor site. In our study we observed several minor complications which were managed uneventfully. Wound dehiscence, infection were complications encountered in both the groups. Infection was observed within one week following surgery in one patient of ridge splitting group.

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Secondary wound healing was achieved by antimicrobial rinse and systemic antibiotics. We did not encounter severe infection, sensory disturbance, severe bleeding, and permanent paresthesia in any of the patient. There was no implant failure in ridge split group or in the onlay bone grafting group there was no difference in terms of implant survival rate between the two groups .In our series of 10 patient scarring was assessed who followed up for a period of 1 month. We found that healing was much better with ridge splitting group with resultant reduced fibrosis compared to onlay bone grafting.

Autogenous bone grafting can be a preferred option in reconstruction of ridge defects where particulate graft does not look to be a definitive option.[14] The desired results can be achieved by using block grafts in cases of large defect with horizontal or lateral bone deficiency. The autogenous block grafting is known to be the gold standard and can be harvested from intra oral and extra oral sites. Meticulous planning plays a key role to perform the procedure with minimum postoperative discomfort and to obtain the desired result from grafting. Recipient site should be exposed first to clinically evaluate for the width and height required for the surgical technique and also the volume of bone graft required from the donor site. A block of adequate size should be harvested and shaped to achieve closest adaptation at the recipient site. While harvesting onlay graft from the symphysis care should be taken to avoid injury to mental nerve and root apices of tooth. The outer margins of block osteotomy of the onlay block graft should be 5 mm away from root apices, mental nerve and basal margin of mandible. The fixation screw should passively pass through the block. Lateral pressure from the screw may result in block fracture The barrier membrane can be used in selective cases where periosteum is not intact or where a particulate graft has been used to augment bone defect. The block graft should be smoothened out to avoid injury to the soft tissue and exposure of the block to the environment.

The ridge splitting procedure, in selective cases can be preferred over onlay bone grafting which requires additional surgical site to harvest the bone block and also takes more time for the completion of implant rehabilitation therapy, as simultaneous implant placement is not possible with onlay bone grafting. The ridge splitting procedure is very technique sensitive and should be done with meticulous treatment planning. The buccal cortical plate should be supported at the time of ridge expansion to prevent sudden fracture. Ridge splitting can be successfully performed in poor to medium density maxillary ridge. The residual gap created may be filled particulate bone graft material but generally undergoes spontaneous ossification. Careful displacement of the buccal plate is essential when ridge splitting is used because abnormal bone healing may result from undue trauma to the cortical plates[15]. With recent advancement in implant science various modifications have been made to conventional ridge split technique and can be selectively be performed in any particular cases.

Conclusion

Rehabilitation of the edentulous jaws with dental implants is a predictable and satisfactory option, however there are some obstacles due to the quantity and quality of the alveolar bone. Various method to restore bone deficiency include guided bone regeneration, ridge split and autogenous block bone grafting. Autogenous onlay bone grafting continue to remain the gold standard for repair of jaw atrophy due to its osteogenic, osteoconductive and osteoinductive properties. Meticulous planning plays a key role to perform to

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perform the procedure with minimum postoperative discomfort and to obtain the desire result from grafting. The ridge splitting procedure is very technique sensitive and should be done with meticulous treatment planning. The ridge splitting procedure, in selective cases can be preferred over onlay bone grafting which takes more time for complete treatment, as simultaneous impant placement is not possible with onlay bone grafting. In our study 10 patients having long term edentulous region with knife edge ridges underwent implant prosthetic rehabilitation. Out of ten patients five patients were treated by ridge split technique while other five using onlay bone grafting. Intraoperative time and complete treatment time required was significantly high in the cases treated with onlay bone grafting. The final bone width gained in the onlay bone grafting group was significantly higher in onlay bone grafting group. We found that healing was much better with ridge splitting group with resultant reduced fibrosis compared to onlay bone grafting. In conclusion, ridge splitting and onlay bone grafting are effective methods of bone augmentation in reconstruction of atrophic jaw. Crestal bone resorption for onlay bone grafting technique was higher than for ridge split technique, but their implant survival rate is same. Ridge splitting technique could shorten the treatment period, decrease postoperative swelling and pain, and eliminate the need for secondary surgery. However long term follow up and larger sample size is needed to assess implant survival rate and crestal bone resorption.

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Legend Figures, Graphs and Tables

Clinical Photographs

Case 1: Reconstruction of Maxillary Defect Using Autogenous Onlay Block Harvested from The Mandibular Symphysis.

Figure 1a: Clinical view of edentulous region of maxilla showing the horizontal ridge defect

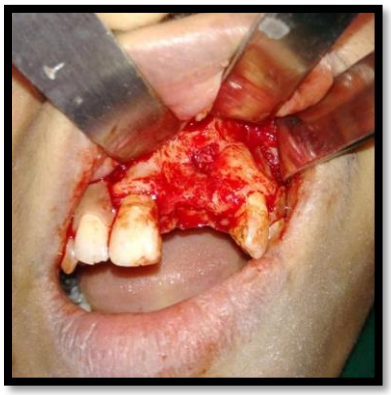

Figure 1b: The mucoperiosteal flap was elevated to expose the ridge crest and buccal cortex

Figure 1c. Rectangular osteotomy completed deep enough to reach the underlying cancellous bone.

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Figure 1d: Osseous splitters are used to laterally separate the bone block

Figure 1e: Small piece of collagen sponge were placed at the donor site Flap was sutured at the donor site

Figure 1f: The onlay graft was fixated on to the recipient site using long fixation titanium screw

Figure 1g: The flap was released and sutured to achieve water tight closure

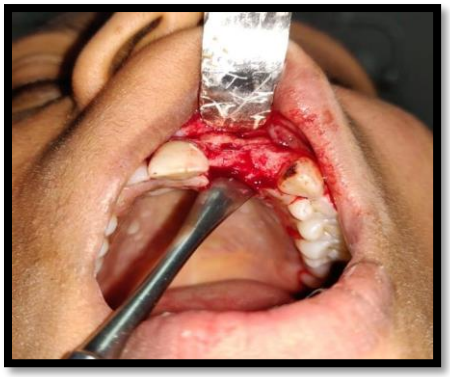

Figure 1h: Following six months healing period the bone grafts are well incorporated for implant placement

Figure1i: Placement of two implants in the reconstructed maxilla

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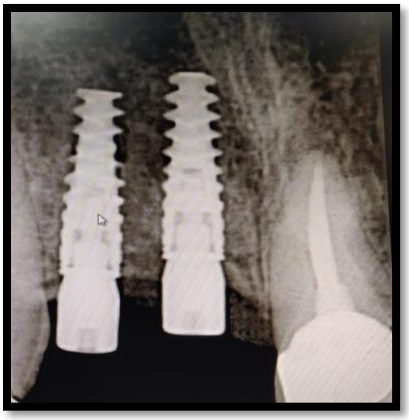

1j. Post implantation radiograph

Case 2 -Ridge Splitting with Simultaneous Implant Placement

Figure 2a: Clinical view of edentulous maxillary region

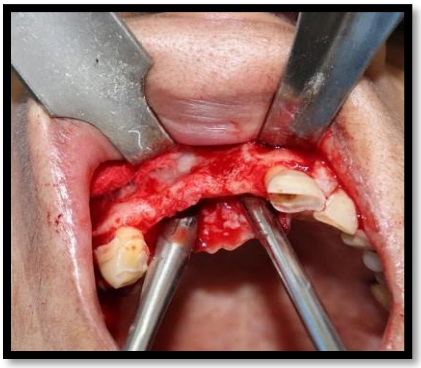

Figure 2b: Incision slightly palatal is made to expose the ridge crest and buccal cortex

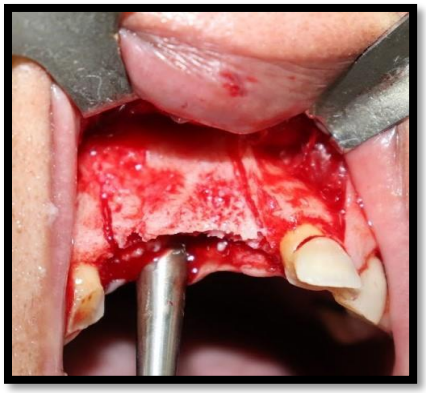

Figure 2c: Two vertical cuts were made on the labial cortical bone

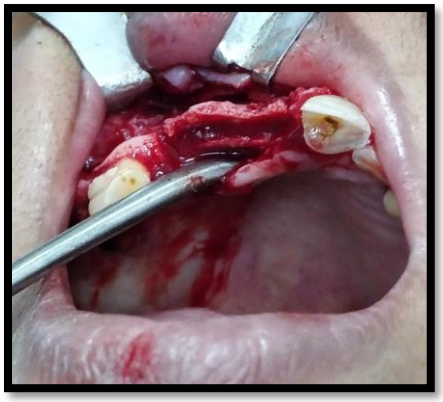

Figure 2d: Mid-crestal cut made, ridge splitters are then used to split and expand the ridge.

Figure 2e: After ridge expansion the osteotomy is completed cortical plate should be supported to avoid fracture during implant insertion.

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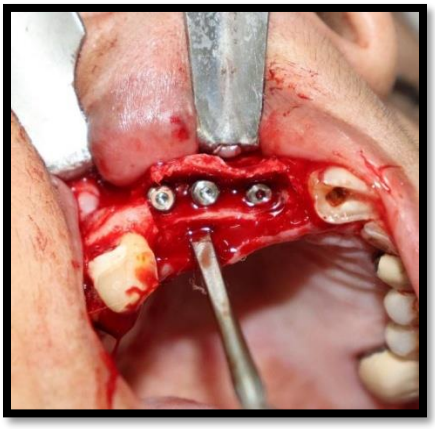

Figure 2f: Implants are inserted in the prepared osteotomy site.

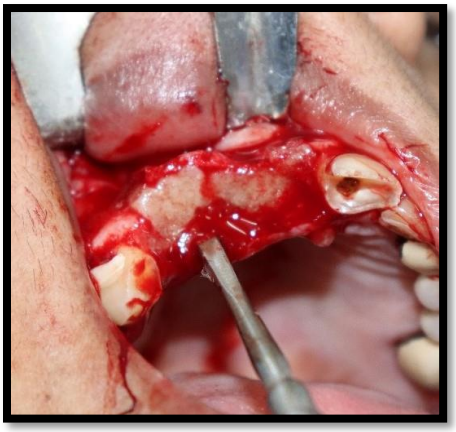

Figure 2g: Bone graft placed

Figure 2h: The flap is sutured to achieve water tight closure

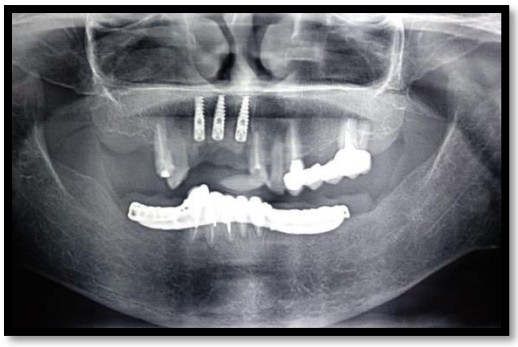

Figure 2i: Post implantation Radiograph.

Graph 1: Comparisonofmeanintraoperativetimeamonggroup1and2study group

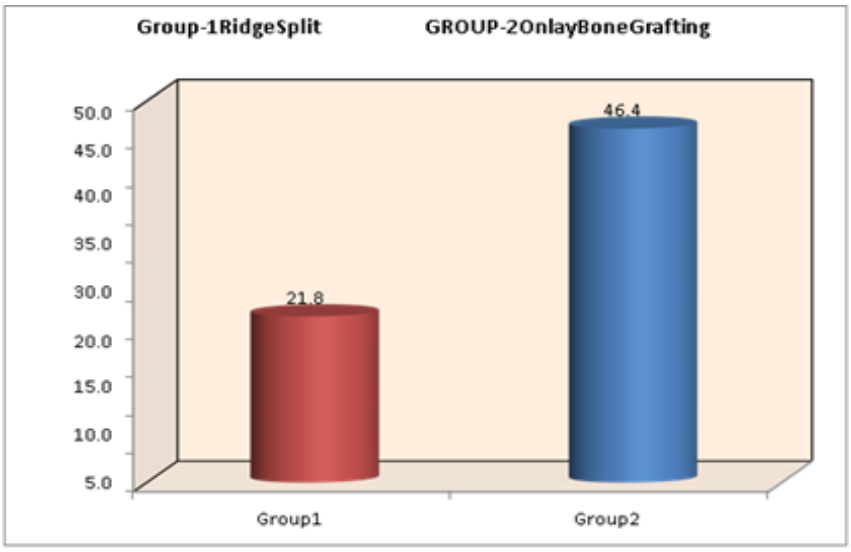

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Table 1:

Comparison of mean Intra Operative Time (in mins) between 02 groups using Independent Student t Test						
Group	N	Mean	SD	Mean Diff	t	P-value
Group1-Ridge Split	5	21.8	2.0	-24.6	-7.417	<0.001*
Group2-Onlay Bone Grafting	5	46.4	7.1			

*-Statistically Significant

Table Shows intraoperative time among group 1 and 2 study subjects. Intraoperative time taken was more in group 1(Ridge split) than group-2 (onlay bone grafting)

Graph 2: Comparison of mean bone resorption among group 1 & 2 study subjects

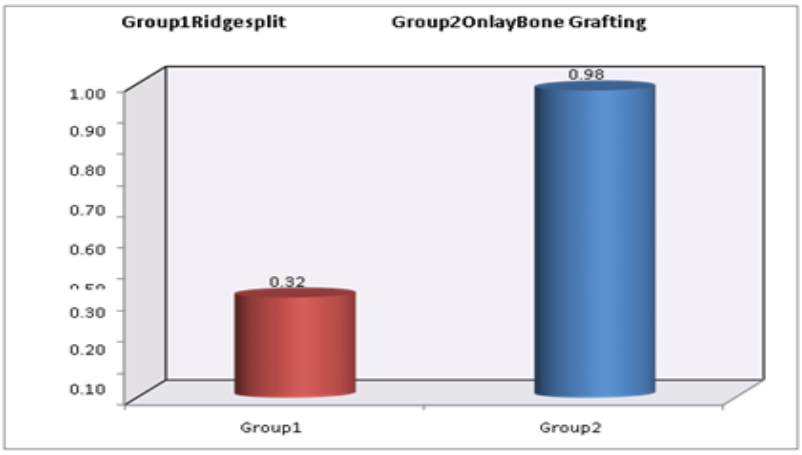
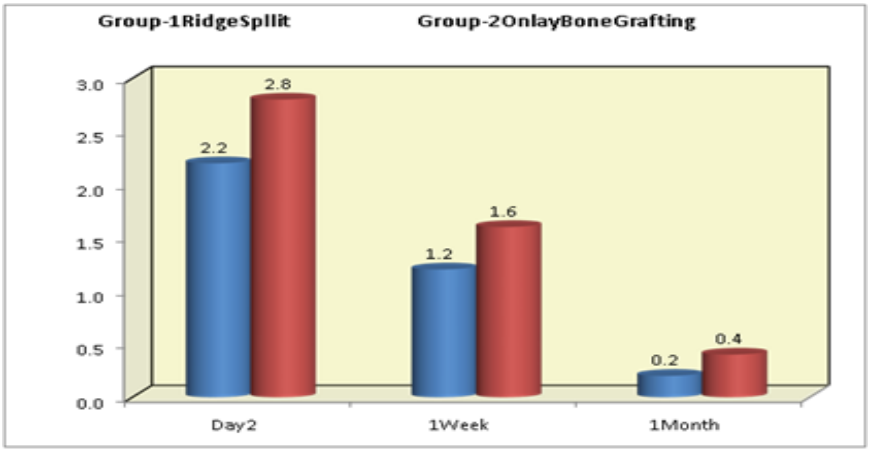


Table 2:

Comparison of mean bone resorption (in mm) between 02 groups using Independent Student t Test						
Group	N	Mean	SD	Mean Diff	t	P-Value
Group1	5	0.32	0.15	-0.66	-7.086	<0.001*
Group2	5	0.98	0.15			

Table shows range of bone resorption among Group 1 & 2 study subjects. Bone resorption was significantly more in onlay bone grafting group than ridge split.

Graph 3: Comparison of mean vas scores for pain on day 2,1 week and 1 month



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Graph 4: Comparison of mean vas scores for pain between different time intervals in each study group.

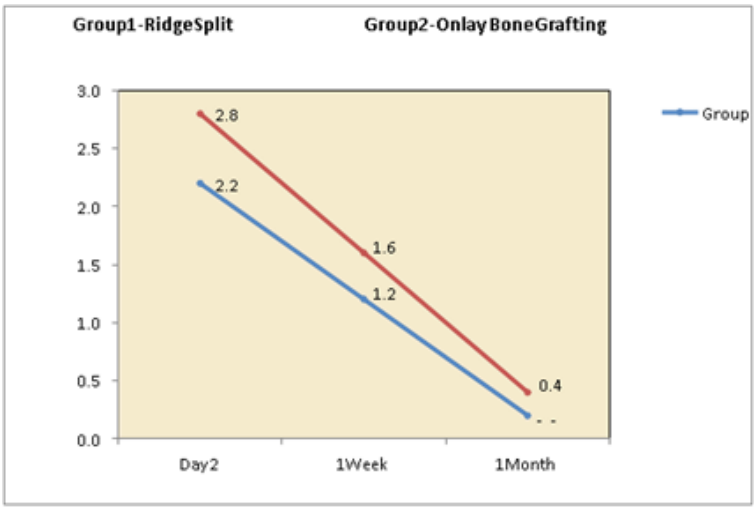

Table 3:

Comparison of mean VAS scores for pain between 02 groups using Independent Student t Test							
Time	Group	N	Mean	SD	Mean Diff	t	P-value
Day2	Group1	5	2.2	0.4	-0.6	-1.414	0.20
	Group2	5	2.8	0.8			
1 Week	Group1	5	1.2	0.4	-0.4	-0.894	0.41
	Group2	5	1.6	0.9			
1 Month	Group1	5	0.2	0.4	-0.2	-0.632	0.55
	Group2	5	0.4	0.5			

Table shows comparison of pain between group 1 and group 2 study subjects using independent student t Test

Table 4:

Comparison of mean VAS scores for pain between different time intervals in each study group using Repeated measures of ANOVA followed by Bonferroni's Post hoc Analysis							
Group	Time	N	Mean	SD	P- Value[a]	Sig. Diff	P- Value[b]
Group1	Day2	5	2.2	0.4	0.005*	D2Vs1W	0.03*
	1 Week	5	1.2	0.4		D2Vs1M	0.04*
	1 Month	5	0.2	0.4		1WVs1M	0.06
Group2	Day2	5	2.8	0.8	0.002*	D2Vs1W	0.03*
	1 Week	5	1.6	0.9		D2Vs1M	0.04*
	1 Month	5	0.4	0.5		1WVs1M	0.06

*-Statistically Significant Note: a. P-value obtained by Repeated Measures of ANOVA b. P-Value obtained by Bonferroni's Posthoc Analysis

Table shows comparison of pain after surgery at day 1, 3, 7 among group 1 and 2 study subjects. At day 1 pain was severe among both the group and it was significantly more in onlay bone grafting group. Pain

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reduced significantly after 1 weekto1.2±.4 and 1.6±.9 respectively. After 1 month follow up pain score was very less and almost same among both the groups. There was statistically highly significant reduction in pain score from day1 to 1 month.

Graph 5: Comparison of mean duration of complete treatment time among group 1 & 2 study subjects

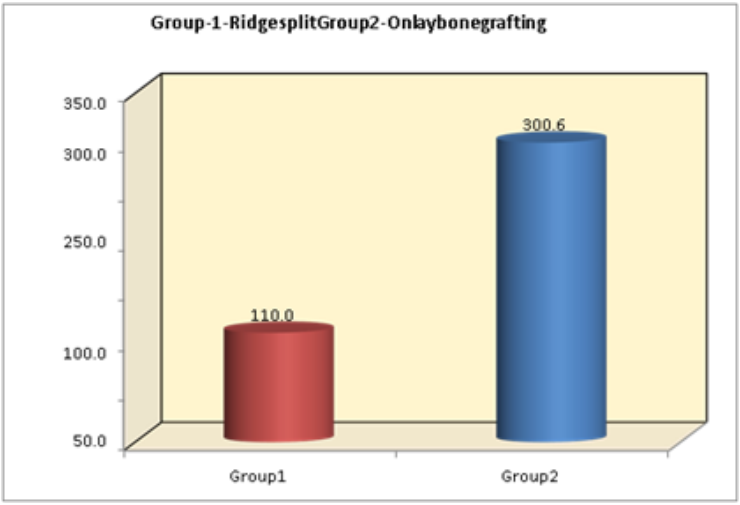

Table 5:

Comparison of mean duration of complete treatment (in days)between 02 groups using Independent Student t Test						
Group	N	Mean	SD	Mean Diff	t	P-value
Group 1- Ridge Split	5	110.0	7.9	-190.6	-38.618	<0.001*
Group 2- Onlay Bone Grafting	5	300.6	7.7			

Treatment time required was significantly among group 2 than group 1 study subject. Mean duration of complete treatment time for was 110±7.9 among group 1 and 300.6±7.7among group 2 respectively.

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