CLINICAL AND COMPUTERIZED TOMOGRAPHIC EVALUATION OF LATERAL RIDGE AUGMENTATION USING CORTICOCANCELLOUS BLOCK AUTOGRAFT HARVESTED FROM THE SYMPHYSIS REGION- 6 MONTH STUDY

Dissertation submitted to

THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY

In partial fulfillment for the Degree of

MASTER OF DENTAL SURGERY

BRANCH II

PERIODONTOLOGY

APRIL 2013

CERTIFICATE

This is to certify that this dissertation titled "**CLINICAL AND COMPUTERIZED TOMOGRAPHIC EVALUATION OF LATERAL RIDGE AUGMENTATION USING CORTICOCANCELLOUS BLOCK AUTOGRAFT HARVESTED FROM THE SYMPHYSIS REGION- 6 MONTH STUDY**" is a bonafide record of work done by **Dr. Ananthi .A** under my guidance during the study period of **2010-2013.**

This dissertation is submitted to **THE TAMIL NADU Dr. MGR MEDICAL UNIVERSITY** in partial fulfilment for the degree of **MASTER OF DENTAL SURGERY, BRANCH II- PERIODONTOLOGY**. It has not been submitted (partial or full) for the award of any other degree or diploma.

27.12.2012

RAGAS DENTAL COLLEGE & HOSPITAL CHENNAI

Dr. T.S.S Kumar, MDS.,
Professor and Head
Department of Periodontology
Ragas Dental College & Hospital
Chennai

Dr. G. Siva Ram, MDS.,
Professor and Guide
Department of Periodontology
Ragas Dental College & Hospital
Chennai

Department of Periodontics,
Ragas Dental College & Hospital,
2/102, ECR, Chennai-119

Department of Periodontics,
Ragas Dental College & Hospital,
2/102, ECR, Chennai-119

Dr. S. Ramachandran, MDS.,
Principal
Ragas Dental College & Hospital
Chennai

PRINCIPAL
RAGAS DENTAL COLLEGE & HOSPITAL
CHENNAI

ACKNOWLEDGEMENT

This dissertation is the result of a lot of effort that has gone in to its making and I wouldn't be justified if I do not acknowledge the people who stood beside me, helping me accomplish this task.

I extend my sincere thanks to ***Dr. S. Ramachandran, MDS,*** *Principal, Ragas Dental College, for his support and guidance during my postgraduate course at Ragas Dental College.*

I express my warmest heartfelt thanks to our respectful sir, ***Dr.T.S.S. Kumar, MDS,*** *Professor and Head, Department of Periodontics, Ragas Dental College, for his valuable guidance, support and encouragement through my postgraduate curriculum. He has been a constant source of inspiration, motivation and encouragement.*

I owe my respectful gratitude to my guide ***Dr. Sivaram, MDS,*** *Professor, Department of Periodontics, Ragas Dental College, for his valuable advice and encouragement during my postgraduate course. I am deeply grateful to him for his patience, support, and guidance during the study process, without whose intellectual insight, guidance in the right direction, this dissertation would not have been the light of the day.*

My deepest and most sincere gratitude goes to ***Dr. K.V. Arun, MDS,*** *Professor, Department of Periodontics, Ragas Dental College, a great teacher who has always been a source of inspiration. I express my personal thanks to sir for being so tolerant, encouraging and understanding. I shall forever remain indebted to him for his over whelming help and meticulous care in*

correcting my mistakes with his valuable advice and friendly encouragement without which I would have never accomplished this particular research.

I extend my heartfelt thanks to ***Dr. Shiva Kumar, MDS.,*** *Professor,* ***Dr. Avaneendra Talwar, MDS.,*** *Reader,* ***Dr. Ramya MDS.****, Reader,* ***Dr. Swarna Alamelu MDS.,*** *Lecturer,* ***Dr. Stelin MDS.,*** *Lecturer,* ***Dr. Santhosh MDS.,*** *Lecturer, Department of Periodontics, Ragas Dental College, for helping me throughout my study and giving me constant support and encouragement.*

I thank ***Dr. Saravanan, Radiologist, Saravana Scans,*** *for his support in helping me to interpret the CT scans during the course of this study.*

My sincere thanks to ***Dr. R. Ravanan, Reader in Statistics,*** *Presidency College, Chennai for the help he rendered.*

It would not be justifiable on my part if I do not acknowledge the help of my fellow colleagues ***Dr.keerthana, Dr.Jasmine, Dr.Teenu, Dr.saumya John and Dr.Gnanasagar*** *and my senior and junior* ***Dr. Bhuvaneshwari, Dr.Ramya Nethravathy,*** *and* ***Dr.Debashish Mishra*** *for their extensive help and support throughout this study and my friends for their criticism and continued support throughout my postgraduate course.*

I extend my thanks to ***Mrs****.* ***Parvathi, Mr****.* ***Chellapan*** *and* ***Mrs****.* ***Subbulakshmi*** *for their timely help throughout the tenure and* ***Mrs. Monica****, staff nurse, Department of Oral & Maxillofacial Surgery, for her helping me in the implant theatre.*

*I would like to thank **Mr. Thavamani** & **Ms. Sudha** for their timely help.*

*I am deeply grateful to my **patients** without whom this task would have been impossible.*

*I would like to especially thank my **parents** for their love, understanding, support and encouragement throughout these years without which, I would not have reached so far. I would like to express my indebtedness for all the sacrifices they have made to see me succeed in my past, present and all my future endeavors. I thank my **in laws** for being patient and understanding all through, and helping me to see the positive side of every event in life.*

*I thank my **sisters,** for their continued encouragement, couldn't have gone through the difficult times without their support.*

*My **husband, Mr. Vasanth** has been my pillar of support and an eternal source of energy in every endeavor of mine. He has been there with me through the most difficult times and helped me complete the study as his own. Without his support and love, this course and this study would have just been a dream.*

*Above all, am thankful to **God** almighty, to have given me the strength to pursue this course and also to have given all these wonderful people in my life.*

CONTENTS

LIST OF TABLES

LIST OF GRAPHS

ABSTRACT

BACKGROUND:

The present study was to evaluate the clinical and spiral computer tomographic outcome of Misch & Judy Division B Ridge defects following reconstructive surgery with the use of corticocancellous block autograft harvested from the symphysis region and were followed for 6 months interval.

MATERIALS & METHOD:

Nine patients selected from the Outpatient Department of Periodontics, Ragas Dental College & Hospital, Chennai, were included in this clinical trial for horizontal ridge augmentation using corticocancellous block autograft obtained from the symphysis region. These patients exhibited with Misch & Judy Division B ridge defect, with missing single tooth in the maxillary and mandibular region. All these patients were assessed clinically and with spiral Computer Tomography at baseline and 6 months. The clinical parameters assessed were mean width of keratinized gingiva, mean changes in the horizontal ridge dimension using spiral computer tomography and mean changes in the vertical bone height at the edentulous site using radiographs were done at baseline and 6 months. Statistical analysis was done using paired T test.

RESULTS:

At the end of 6 month period there was no significant difference in the mean width of keratinized gingiva at the augmented sites.

Spiral Computer Tomographic analysis at the augmented sites exhibited an average increase of 1.6 mm at the crest level, 2.9mm at 2mm level from the crest and 2.8mm at 4mm from the crest level 6 months post operatively.

In terms of radiographs at the vertical bone changes at the augmented sites most of the sites exhibited loss of crestal bone at 6 months with a change of 2.5mm.

CONCLUSION:

The present clinical study clearly demonstrates the use of corticocancellous autogenous block graft in horizontal ridge augmentation of Misch & Judy Division B ridge defects as a predictable treatment modality.

KEYWORDS:

Lateral / Horizontal ridge augmentation; Autogenous Block Graft; Spiral Computer Tomographic evaluation; alveolar ridge deficiency.

INTRODUCTION

Implant has been widely used in modern dentistry in restoring partial / complete edentulous state. Ridge augmentation has become a standard protocol for inadequate ridge dimension prior to implant placement at a more ideal position.[1,41]

The key to implant success is osseointegration for which an adequate bone density, ridge width and height with a minimum of 2mm of bone surrounding the dental implant at its crest.[42] Bone augmentation is required when tooth loss leads to loss of bone volume prior to implant positioning.[3,41] In a clinical scenario that limits the implant placement includes traumatic extraction, periodontal disease developmental defects ect.[3]

After a tooth extraction there is an accelerated amount of alveolar bone loss which occurs within the first few months. The estimated amount of residual ridge resorption is 60% in height and 40% in width at the end of a year.Residual ridge resorption can be principally treated by using guided bone regeneration with or without membrane.[17,8]

The treatment modality for residual ridge defects can be broadly grouped to the existing width and its height of the alveolar ridge. When the residual ridge defects is in the range of 4-6mm buccolingually with minimal vertical ridge deficiencies less than 3mm, block graft is principally advocated as atreatment protocol.[6]Block grafts can be sourced as autogenous (or)

allogenic form. Autogenous block graft remains the gold standard for residual ridge augmentation because of its unmatched osteogenic viability which offers for the bone regrowth and avoidance of histocompatability problems.[59,62,69]

Autogenous bone grafts are harvested from intraoral and extra oral sites and used as a graft material. Extra oral site include calvarium, ribs and tibia, however for localised ridge defects block grafts from intra oral site offer advantage over the counter part by convenient surgical access or minimal donor site morbidity and cost effective. Bone grafts harvested from chin or ramus provides adequate bone to overcome ridge width deficiencies.[39,47,76]

Block graft harvested from the symphysis region is primarily indicated in horizontal augmentation of 4 – 7mm. The range ofcorticocancellous graft thickness is 3-11mm with most of the region providing an average block graft thickness of 4 – 8mm and in terms of density it is D1 and D2 which is ideal for primary stability during implant placement.[70]

Mandibular symphysis bone grafting have been successfully used in variety of clinical scenario and studies have substantiated the positive clinical outcomes radiographically and histomorphometrically.[50] The volume of hard tissue gained by using the block graft seems to be sufficient for optimal implant placement and for its primary stability.[21]

Radiographic evaluation provides a fair details of the residual ridge width with pre operative and post operative values. It can be used additionally

to substantiate the amount of bone gain at different time period. It also aids in assessing the quality of the augmented bone to that of its native bone.[22]

In order to access the changes in the bone dimension prior to augmentation and also for post operative evaluation. To conventional radiographic aids, spiral CT have a added advantage not only in assessing the quantity of the bone but also the bone quality. Spiral Computer Tomography can also serve as a tool for proper guidance for placing an implant.Spiral Computer Tomography can be used as a standard observative guidance at different time intervals. It gives a three-dimensional view which gives appropriate ridge dimensions.[11] It can also be used to accurately analyze the bone quality and morphology and is far more accurate in assessing important anatomical structures than conventional imaging techniques, moreover all the vital anatomy is available in multiple slice.[4]

The present study clinically and computer tomographically evaluates the quantity of bone dimension at localised augmented ridges using autogenous block graft harvested from the symphysis region at 6 month follow up.

AIMS AND OBJECTIVE

The purpose of the study was

1. To evaluate the clinical outcome of corticocancellous autogenous block graft in the treatment of Misch & Judy Division B ridge defect over a period of six months.
2. To evaluate with spiral Computer Tomographically the effect of corticocancellous autogenous block graft in the treatment of Misch & Judy Division B ridge defect over a period of six months.
3. To radiographically evaluate the crestal bone changes following corticocancellous autogenous block graft in the treatment of Misch and Judy division B ridge defect over 6 months time period.

REVIEW OF LITERATURE

During the last few decades, implants have become a highly predictable surgical procedure due to the advent of osseointegration and advances in biomaterials, techniques and newer equipments that have contributed to increased dental implant in restoring partial and complete edentulous patients.[82] An important prerequisite to predict long term success for osseointegrated implant is a sufficient volume of healthy bone at recipient sites.[42] However a sufficient amount of bone volume is frequently lacking as a result of trauma, tooth loss or chronic disease such as periodontitis.[74]

With tooth loss the alveolar bone undergoes an irreversible and progressive process known as resorption ensuing in an unavoidable loss of bone width and height.[5,78] As a result the ideal 3 dimensional implant placement may be compromised. Bone augmentation techniques are employed to increase residual ridge height and width so that the implant can be placed in the ideal 3D and restoratively driven position.[43]

RESIDUAL RIDGE RESORPTION

Carlsson et al (1967)[18] The alveolar ridge undergoes accelerated bone loss within the first 6 months of tooth extraction resulting in an eventual estimated 40% loss of the ridge height and 60% loss of ridge width. Resorption of the buccal plate occurs at a faster and greater extent compared to the palatal or lingual plates because of the loss of bundle bone.

Atwood et al in (1971)[7] has described residual ridge resorption (RRR) as morphologic changes of the alveolar process following tooth extraction. He studied the bone loss patterns of edentulous alveolar ridges and suggested various etiologic factors that cause Residual Ridge Resorption(RRR) and categorized the factors in four major groups as follows:

1.Anatomic, 2.Prosthetic,3.Metabolic and 4.Functional.

CLASSIFICATION OF RIDGE DEFECTS

Different authors have proposed various classifications for ridge defects. **Seibert in (1983)**[80] performed a study on reconstruction of deformed partially edentulous ridges using full thickness onlay grafts and he proposed a classification for ridge deformities

SEIBERT'S CLASSIFICATION FOR RIDGE DEFORMITIES(1983)[80]

Class I: Buccolingual loss of tissue contour with normal apicocoronal height

Class II: Apicocoronal loss of tissue with normal buccolingual contour.

Class III: Combination of buccolingual and apicocoronal loss.

Allen in (1985)[2] further modified the classification technique for localized ridge augmentation with quantification of the amount of tissue loss.

Type A: Apicocoronal loss of ridge contour.

Type B: Buccolingual loss of ridge contour.

Type C: Combined buccolingual and apicocoronal loss.

The ridge is further described by assessing the depth of the defect.

Mild: Less than 3mm

Moderate: 3-6mm

Severe: Greater than 6mm.

Misch and Judy in (1987)[58] classified the ridge as follows:

Division A (Abundant Bone): Alveolar bone > 5mm width, > 10-13mm height and mesiodistal distance > 7mm

Division B (Early Sufficient Bone): Slight to moderate atrophy. Decrease in width 3-5mm, Height 10mm

Division C (Compromised Bone): Width < 2.5mm, height < 10mm

C-h: Compromised height

C-w: Compromised width

Division D (Deficient Bone): Severe atrophy, basal bone loss

Tuhler et al in (1997)[88] studied the distribution of bone quality in patients and demonstrated that the anterior mandible had the densest bone, followed by the posterior mandible, anterior maxilla and posterior maxilla.

Misch(1999)[59] proposed four bone density groups based on the macroscopic cortical bone characteristics.

D1 bone – Dense cortical bone

D2 bone – Dense to thick porous cortical bone on the crest and coarse trabecular bone underneath

D3 bone – Bone has a thinner porous cortical crest and fine trabecular bone within

D4 bone – No crest cortical bone.

Misch (1999)[59] proposed bone density classification wichmay be evaluated on the CT images by correlation to a range of **Hounsfield** units:

D1 – More than **1250** HUF units.

D2 – **850-1250** HUF units.

D3 **– 350-850** HUF units.

D4 – **150-350** HUF units.

D5 – Less than **150** HUFunits.

TREATMENT MODALITIES FOR RIDGE AUGMENTATION

The end goal of restorative therapy is to provide a functional restoration that is in harmony with the adjacent natural dentition. Residual ridge resorption can be treated by bone augmentation.[15]

Bone augmentation techniques can be applied in socket preservation procedure, in edentulous ridge grafting[36], horizontal ridge augmentation,[82] vertical ridge augmentation,[72] and sinus floor augmentation.[53] To maximize the results for each of these applications, a variety of surgical techniques is employed. These procedures involve the use of bone grafting with different type of grafts material such as particulate graft, block graft or a combination of both without membrane.[15]

CLASSIFICATION OF RIDGE AUGMENTATION TECHNIQUES ACCORDING TO SEVERITY OF RIDGE DEFICIENCIES (ArunK.Garg)[6]

Ridge Thickness	Procedure
8-10mm	Barrier membrane alone
7-8mm	Particulate graft and barrier membrane with pin fixation
6-7mm	Osteotomes for ridge expansion
5-6mm	Allogenic block of bone
4-5mm	Autogenous block of bone
1-4mm	Downfracture of the maxilla or titanium mesh crib or Distractionosteogenesis

GUIDED BONE REGENERATION

When the residual alveolar ridge dimension is atleast 7 to 8 mm buccolingually/palatally, a membrane with some particulate graft material should be considered. The graft material can consist of autogenous bone, an allograft (such as demineralized or mineralized freeze-dried bone) or an alloplast / xenograft.

HISTORICAL PERSPECTIVE

The principle of using barrier membranes was first evaluated in the late **1950'**s and early **1960'**s by the research teams of **Bassett et al** and **Boyne et al**[12,14] for the healing of cortical defects in long bones and osseo facial reconstruction.

Murray et al (1957)[61] conducted a clinical study on new bone growth and stated that there were three things necessary for new bone formation: the presence of a blood clot, preserved osteoblasts and contact with living tissue.

Hurley et al in (1959)[40] proposed the concept of GBR where cell occlusive membranes were employed for spine fusions. GBR are based on the principles of the use barrier membranes for space maintenance over a defect, promoting the ingrowth of osteogenic cells and preventing migration of undesired cells from the overlying soft tissues into the wound.

Seibert & Nyman (1983)[80] presented a pilot study of localized ridge augmentation in dogs and suggested that, in areas where the membrane was not supported, some collapse occurred. In addition, less regeneration was observed in the areas where the membrane did not retain its shape.

Lazzara et al (1989)[48] first reported the use of GBR techniques with implants in immediate extraction sites. Reports of the study have shown a benefit from the use of ePTFE membranes in the immediate placements of endosseous implants in extraction sites.

Buser et al (1995)[17] When a membrane is combined with graft-filling material in guided bone regeneration techniques the membrane has two functions. Its primary purpose is to create a barrier against non osteogenic cells derived from the mucosa. Its second function is to preserve the graft from post operative resorption.

Hermann &Buser (1996)[38] discussed five surgical factors that are required to achieve predictable results with GBR procedures:

1. Achievement of primary soft tissue closure and healing.
2. Use of an appropriate barrier membrane.
3. Stabilization and close adaptation of the membrane to the surrounding bone.
4. Creation and maintenance of a secured space.
5. Sufficiently long healing period.

Parodi et al (1998)[65] evaluated the possibility of expanding an edentulous ridge spanning two or more teeth by a two-step technique with bioresorbable collagen membranes. Sixteen healthy patients were treated, the baseline of the crest width was less than or equal to 4 mm. At implant placement, the mean increase in the size of the crest was 2.49 mm (+/- 1.61 mm). In 12 out of 16 patients (75%) it was possible to insert 27 implants according to the prosthetic need established previously. All implants were successfully loaded.

Monica Fernandes Gomes et al (2002)[60]in a case control study evaluated the osteoconductive properties of autogenous demineralized dentin matrix (ADDM) on surgical defects in the parietal bone of rabbits using the guided bone regeneration techniques using polytetrafluoroethylene (PTFE) membrane. The ADDM slices appeared to stimulate new bone formation implicating that bone repair was accelerated on the bone defects treated with ADDM when compared to the control group.

Hammerele et al (2002)[37] augmented ridge using bioresorbable membranes and deproteinized bovine bone mineral and concluded that after a healing period of 9-10 months, the combination of demineralized bovine bone mineral (DBBM) and a collagen membrane was an effective treatment option for horizontal bone augmentation before implant placement.

Fugazzoto et al (2003)[29] in a clinical and histomophometric study treated ninety sites which required either sinus augmentation, socket preservation or ridge augmentation with bovine bone (Bio-Oss) with resorbable or titanium reinforced non-resorbable membranes and core biopsies were taken after 12 months, which revealed evident new bone formation.

Proussaefs et al (2003)[73] in a pilot studyused resorbable collagen membrane in conjunction with autogenous bone graft and inorganic bovine mineral for buccal/labial alveolar ridge augmentation as a pilot study. All patients received labial/buccal alveolar ridge augmentation. Histologic and histomorphometric analysis from the grafted area evaluated new bone formation, and osteoconductivity of inorganic bovine bone mineral (IBM). Results indicated that resorbable collagen membranes may be used as barriers for labial/buccal alveolar ridge augmentation procedures

Giuseppe Corinaldesi et al in (2007)[33] in a comparative study using autogenous bone and autogenous bone with bovine porous bone mineral using titanium micromesh for alveolar bone augmentation in twelve partially edentulous patients and observed histologically and histomorphometrically that augmentation with both the materials showed compact bone with a well-organized bone.

Sharon R. Bannister et al in (2008)[81] performed a staged approach of ridge augmentation in 11 region with a mixture of autogenous bone and

anorganic bone with platelet-rich-plasma and a bioresorbable collagen membrane. Healing was uneventful, although after 4 months upon flap reflection, no regenerated hard tissue was found. The site was regrafted with an allograft/xenograft mixture and covered by a Bioabsorbable collagen membrane. Wound healing was uneventful and a histologic core was obtained at implant placement 5 months later. The histologic core obtained consisted of trabeculae of viable lamellar bone and associated fibrous connective tissue without a significant inflammatory cell infiltrate. He concluded that failure of materials for guided bone regeneration usage is rare.

AUGMENTATION WITH BLOCK AUTOGRAFT

Autogenous bone is an organic material harvested from the patient, it forms new bone by osteogenesis, osteoinduction, & osteoconduction.[6]

Autogenous bone grafts have been used in block and particulate forms. Autogenous bone has a long history of use and is considered the gold standard for graft materials in the field of Periodontics and implantology (**Goldberg V 1987**).[35]This type of graft retains the matrix, with its bone inductive properties and osteogenic potential. It does not induce an immunologic reaction. Osseous defects have been successfully treated with intraoral autogenous graft.

Borstlap WA et al (1990)[13] reported a comparative study between chin and rib graft and concluded that in the reconstruction of maxillofacial

structures, marginal bone resorption for mandibular chin grafts ranged from 0 to 25%.

Bone graft resorption during the healing phase has been extensively reported **Linn et al (1990).** To reduce the amount of bone resorption when planning an onlay graft to the facial skeleton, it is advisable to use membranous bone and to stabilise the graft firmly in the recipient site. **Phillips & Rhan (1990)**.[67]

Jensen and Sindet-Pedersen (1991)[42] did a clinical report on autogenous mandibular bone graft on severly atrophied maxilla with a simultaneous implant placement and concluded 15% (1 to 2 mm) marginal bone resorption rate in onlay autogenous grafts combined with endosseous implants.

Ten Bruggenkate CM et al (1992)[83] conducted a preliminary report on autogenous bone graft in conjuction with placement of ITI endosseous implants and stated that the autogenous bone grafts without membranes show *a* resorption rate of up to 50% during the first 6 months of healing.

Misch et al in (1997)[59] stated that possible complications while harvesting block graft with intraoral donor sites include altered sensation of teeth, neurosensory disturbances and infections. Autogenous block grafts when compared to particulate bone marrow have been associated with reduced osteogenic activity and slow revascularization.

Widmark G(1997)[93] presented case report in which mandibular symphysis bone graft was used in the anterior maxilla for single tooth implants stated bone harvested from the mandibular symphysis is mainly cortical in nature, allowing application of rigid fixation in situ and thus providing good primary stability.

Lundgren et al (1997)[53] conducted a clinical study on Bone grafting to the maxillary sinuses, nasal floor and anterior maxilla in the atrophic edentulous maxilla and concluded that most of the graft resorption takes place during the first 6 months. Cortical thicknesses of donor bone and donor bone density are factors influencing bone resorption. Oversized corticocancellous grafts, with a thick resorption-resistant cortex should be harvested in order to maintain enough graft volume after the initial resorption phase. This will allow for long implants with good stability.

Urbani et al (1998)[90] augmented three maxillary defects and three mandibular defects with chin grafts and resorbable pins without membranes. At 6 months, the areas treated showed successful ridge augmentation on exposure for second surgery, radiographic evaluation of the block grafts showed successful augmentation.

Lemperle et al (**1998)**[49] conducted a comparative study on the healing of large calvarial and mandibular defects in mongrel dogs evaluating bone regeneration with and without periosteal preservation. Defect protection by the periosteum alone seemed sufficient to allow for healing, even in large CSDs

(30-mm segmental defect). When the periosteum was absent, spontaneous bone formation was limited and benefited from osteoconductive grafting.

Tolman DE (1999)[87] stated that autogenous bone harvested from intraoral or extraoral sites is the most predictable osteogenic organic graft for osseous tissue regeneration.

Thomas et al in (1999)[86] reported three cases with knife-edged mandibular alveolar ridges, in which the crestal portion of the knife-edged ridge was used as grafting material. The grafts were rotated by 180 degrees' and were fixed to the residual ridge below the osteotomy line which was placed on the crest of the ridge, by means of mini screw. After 3 months of healing, implants were placed in the augmented region.

Weibull et al (**2000)**[92] In a recent long-term retrospective study (average, 7.5 years) post symphysis graft, and reported that the cephalometric examination in 45 patients, with a mean age of 49 years, showed good remineralization in 42 (93.3%). However, bone healing after symphysis harvesting did not show regeneration to the preoperative level and a radiographic concavity was detected in the majority of cases.

Fukuda et al (2000)[30] in a clinical study on bone grafting to increase interdental alveolar bone height for placement of an implant reported that the two-step procedure is best for patients with insufficient alveolar bone. Chin bone as a donor site; topographic accessibility, reduced morbidity and the

absence of visible scars, and less resorption of grafted bone compared with that of extra orally harvested bone.

De Andrade et al (**2001)**[20] conducted a in vitro study on 12 human cadaver mandibles and found that the position of the incisive nerve that innervates the lower incisors was 2.67±0.65mm from the buccal plate on the right side and 2.64±0.67mm on the left side. This means that inorder to avoid injury to the incisive nerve during the bone harvesting procedures, bone must be procured superficially.

Nkenke et al (2001)[63] in his prospective study examined the morbidity of harvesting of chin grafts and concluded that 21.6% of the examined lower premolars and front teeth had lost their pulp sensitivity at the first postoperative examination after monocortico spongious bone graft were harvested atleast 5mm from the apices of the lower incisors.

Hadi Antoun et al (2001)[36] stated in his preliminary study on crestal enlargement in 22 consecutive patients **ten Bruggenkate et al. (1992**) has shown 50%resorption of the onlay grafts after 6 months, with a final mean crestal width gain of 1.6 mm. These results were confirmed in another study published by the same authors **Krekeler et al (1993**). In comparison, subjects undergoing crestal augmentation with graft alone experienced higher width gain at 6 months(mean of 2.9 mm).

Marizo et al in (2002)[55] histologically analyzed reconstructed maxillary ridges using autogenous bone from the chin and iliac crest in ten patients and concluded that improvement in bone quality of the receptor site was evident independent of the size of the reconstruction, although the chin grafts presented better bone quality. It was also emphasized that a period of 4 months is sufficient for the placement of osseointegrated implants in reconstructed areas.

Periklis Proussaefs et al (2002)[66] presented a clinical, radiographic, and histologic/ histomorphometric analysis of the use of a mandibular ramus block autografts harvested from the ascending ramus area for vertical alveolar ridge augmentation in eight patients. The results showed that mandibular block autografts could maintain their vitality when used for vertical ridge augmentation. An average of 5.12mm of vertical ridge augmentation was achieved and 17% resorption was seen 4 to 6 months after bone grafting. The Radiographic measurements 4-6months after surgery revealed an average of 6.12mm of vertical augmentation.

Balaji SM et *al* (2002)[10] conducted a study on management of deficient anterior maxillary alveolus with mandibular parasymphyseal bone graft for implants and concluded that Intraoral donor sites were found to be convenient sources of autogenous bone in alveolar reconstruction. The advantage of this method includes its intraoral access, proximity of the donor

site, and low morbidity. These grafts require short healing periods, exhibit minimal resorption and maintain their dense quality

Maiorana et al (2005)[54] conducted a prospective study on Reduction of autogenous bone graft resorption by means of Bio-Oss coveragein which he indicated that the placement of bovine bone over onlay block grafts without a membrane reduced natural bone resorption after a guided bone regeneration procedure.

Proussaefs (2005)[72] reported The use of intra orally harvested autogenous block graft for vertical alveolar ridge augmentation and concluded 17.4% resorption at 4 to 6 months after bone grafting without a membrane when the ascending mandibular bone (chin or ramus) was used as the donor site.

Ofer Moses et al (2007)[64] in his case report treated a 65-year old woman with iliac crest autogenous bone graft for severely resorbed mandible and stabilized the graft by four dental implants anchoring it inferiorly to the residual mandibular basal bone. The patient was followed for 17 years, during which the prosthesis was replaced twice.Oral rehabilitation was successful with no detectable clinical signs of bone loss.

Gerry et al (2007)[31] evaluated the morbidity of mandibular bone harvesting from chin and ascending ramus by assessing the medical records and performing routine clinical and radiographic examinations upto 12

months. In addition the patients were asked to complete a questionnaire on the subjective complaints related to the procedure. He concluded that there was incomplete bone fill of the donor region and that bone harvesting from the retromolar region was the best option.

Gerry M et al (2007)[31] in a comparative study assessed 45 patients who had been subjected to mandibular harvesting from chin region and retromolar region and concluded that no postoperative alteration in chin contour was observed in the present study either clinically or radiographically**.** Radiographic evidence of incomplete bony regeneration has been reported in elderly patients.Ptosis of the chin did not occur and can be prevented by avoiding complete degloving of the mandible. The intra sulcular incision employed to gain access to the underlying bony surface generally heal by second intention or third intention, depending upon the degree of flap adaptation. It has been shown that bone loss after flap reflection is inevitable, with the undesirable consequence of recession of the free gingival margin during the healing period at the donor site.

Takeya et al in (2008)[82] reconstructed the vertical and horizontal dimensions of the alveolar ridges using a mandibular bone block and evaluated clinically, radiographically and histologically. After 6 months of treatment, 7mm of horizontal and 3 mm of vertical augmentation were gained. Histologic observation showed that the grafted bone was well integrated with the original bone.

Tezulas et al in (2009)[84] evaluated the decontamination of autogenous bone with oral microorganisms that may cause augmentation failure due to complications associated with infection and determined that bone particles collected with clindamycin or chlorhexidine solutions. Both of the agents effectively decontaminated the collected bone particles.

Weibull et al (2009)[92] conducted a retrospective long-term follow-up study regarding the morbidity after chin bone harvesting. A group of 60 patients who were augmented with bone grafts from the mandibular symphysis for insufficient bone volume in the maxilla were followed for a period of one year. This study indicated that the most frequent disturbance was impaired sensibility in the soft tissues of the chin. Radiographic examination revealed that bone healing after chin graft harvesting did not regenerate to the preoperative level.

Schwartz-Arad (2009)[79] in his case report observed healing and remodeling of the donor area that enabled the reuse of the site for bone block harvesting in 5 subjects . The present evidence suggest that intraoral bone source could serve as a renewable reservoir of high- quality bone and symphysis as a viable source for block graft.

Fernando Verdugo et al (2010)[26] stated that human mandibular donor site defect healing is primarily size and time dependent. Osseous defect >0.5cc with an average healing time of 7.2months showed a mean of 63.8% bone fill, whereas those <0.5cc and healing period of 34.2months averaged 81%. Such

factors as preservation of the periosteum and symphysis cortical midline could potentially influence osseous defect repair.

Radiographic assessment of bone augmentation using spiralComputerised tomography

Spiral computer tomography is the third generation design, in spiral computer tomography the x-ray sources are attached to a freely rotating gantry. During the scan the table moves the patient smoothly through the scanner; the name derives from the helical path traced out by the x-ray beam.

Spiral CT can be used as a standard observative guidance at different time intervals. Spiral Computerized tomogram gives a three-dimensional view which gives appropriate ridge dimensions. It can also be used to accurately analyze the bone quality and morphology and is far more accurate in assessing important anatomical structures than conventional imaging techniques, moreover all the vital anatomy is available in multiple views.

Bahr W, Coulon JP (1996)[9] studied the limits of mandibular symphysis as a donor site for bone grafts in early secondary cleft palate osteoplasty and concluded the bone availability using CT in patients with a mixed dentition. They found the average amount of bone to be 1.0mL sufficient to treat small to medium sized defects.

Urbani et al (1998)[90] stated that computerized tomography demonstrated preservation or mild resorption of the external cortical plate of all bone grafts with the well defined rodiopaque profile of the pins penetrating

the bone during the first 3 months. The 6- month mandibular radiographs showed the absence or poor definition of the outer cortical layer of the grafts with the pin profiles progressively disappearing.

Barry I simon (2000)[11] stated in his study patients requiring 3-dimensional computerized imaging had CT scans taken with specially designed imaging stents, characterized by a horizontal reference plane parallel to a proposed restorative occlusal plane and with vertical positional markers. The results clearly indicated that a highly significant percentage of bone loss ranging from 39.1% to 76.3% during a 4 month healing interval.

Antoun et al (2001)[4] did a prospective randomized controlled clinical study comparing two techniques of bone augmentation, onlay graft alone or associated with a membrane.

The CT-scan measurements were available for all subjects, except for one patient. There was no significant difference between the groups in terms of width gain, with a mean of 4.2 mm in the membrane group versus 2.5 mm in the graft alone group. Results of width gain demonstrated with CT-scans were in accordance with those obtained with the callipers, showing a trend towards an increased width in the membrane group as compared to the graft alone group. This radiographical method is reliable and may be used to assess techniques of bone augmentation.

Cordaro et al (2002)[19] stated that in only 4 lower jaw caseswere CT scans reformatted with Denta scan software was available. In agreement with other authors, we believe that in criticalcases reformatted CT images do not

alwaysprovide a precise treatment guidewhen the decision to graft or not to grafthas to be made (Jacobs et al. 1999).

Devorah Schwartz-Arad[21] in the year **2005** used CT analysis to evaluate bone shape (mesio-distal width and vertical distance from the maxillary sinus and nasal cavity) and bone angulation to determine the quality and quantity of available alveolar bone prior to implant placement.

Ofer Moses (2007)[64] did a clinical examination using a 3-dimensional computerized tomography revealed extreme atrophy of both the mandible and maxilla. In the mandible, only 2 to 3 mm of peripheral cortical bone anterior to the mental foramina was evident. The geniohyoid process was prominent, and the mental foramina were located lingual and inferior to the residual ridge of bone.

A radiographic study was done by **Pommer B et al (2008)**[71] using CT scans on 50 dentate mandibles to evaluate the current recommendations for the location of the harvest zone with respect to the course of the mandibular incisive canal the intrabony continuation of the mandibular canal mesial to the mental foramen. Results showed respecting previous recommendations (5mm below the apices of lower mandibular teeth) for chin bone grafting, the content of the mandibular incisive canal was endangered in 57% of the CTs. Therefore, new safety margins are suggested: the chin bone should be harvested at least 8 mm below the tooth apices with a maximum harvest depth of 4 mm and intact lower border of mandible. Authors concluded that applying the new safety recommendations and proper patient selection in chin bone

harvesting could reduce the risk of altered postoperative tooth sensitivity due to injury of the mandibular incisive nerve upto 16%.

Takeya uchida et al (2008)[82] in a radiographic study stated that the quality and quantity of reconstructed bone were assessed using CT and simplant at 5 months after grafting. The quality of the reconstructed bone seemed similar to that of the original bone in the simplant analysis.

Schwartz-Arad et al (2009)[79] A computed tomography taken 5 months after bone augmentation to evaluate available bone for implant placement showed complete healingof the donor sites in the patients.It was impossible to identifythe borders of the bone defect created during thefirst harvesting procedure. Bone continuity was observedbetween the new bone at the donor defect sitesand the surrounding bone. As expected from the CT scans of the newly formed bone, it was possible to harvest bone blocks from the original sites using the sametechnique with an oscillating saw because there was a high consistency of bone.

Verdugo et al (2010)[26] CTwas used for the postoperative measurements in this study. Human mandibular donor- site defect healing is primarily size and time dependent.

Osseous defects ≥ 0.5 cc with an average healing time of 7.2 months showed a mean of 63.8%bone fill, whereas those ≤ 0.5 cc and healing period of 34.2 months averaged 81%. This technology has been used as a non invasive method to evaluate bone volume and has been shown to be a highly

accurate instrument of measuring changes in bone stereology and microarchitecture.

Verdugo et al (2010)[26] stated that CT was used for the postoperative measurements in his study. This technology has been used as a non invasive method to evaluate bone volume and has been shown to be a highly accurate instrument of measuring changes in bone stereology and microarchitecture.

IMPLANT SUCCESS IN REGENERATED BONE

The ultimate goal for many guided bone regeneration procedures is successful implant placement. Several studies have examined the long term stability of implants placed in grafted bone.

Nevins et al (1998)[62] studied on long-term success rate of implants placed in regenerated bone. 526 implants placed in either at the time of grafting or later using a staged approach. The grafting were done using autogenous bone or with allogeneic bone. The follow-up time ranged from 6 to 74 months post-loading. The overall success rate was 97.5%. In addition there was no difference in the success rates of the implants placed in autogenous grafted bone compared to those placed in allograft bone.

Von Arx T et al (1998)[91] reported a retrospective study with a follow up of 1-3years in which 100% survival rate was reported for 27 implants placed into bone regenerated using mandibular block graft protected by microtitanium meshes after 1-3 years of functional loading.

Fritz et a1 (2001)[28] evaluated the success of implants in regenerated bone from a histologic perspective. Implants were placed in monkeys in both native and regenerated bone and then loaded with a fixed prosthesis for one year. The same radiographic and histologic appearance was seen in both native bone and regenerated bone sites. Also, bone to implant contact showed no significant difference between the implants in native bone (59%) and the implants in regenerated bone (65%).

A study was done by **Cordaro et al (2002)**[19] on a group of 15 patients with 18 partially edentulous alveolar segments who needed alveolar ridge augmentation for implant placement. They were treated using the mandibular ramus or symphysis block graft. The grafts were placed as lateral or vertical onlay grafts and fixed with titanium osteosynthesis screws after exposure of the deficient alveolar ridge. After 6 months, mean lateral and vertical augmentation showed decrease by 23.5% and 42%, respectively, during bone graft healing (before implant insertion).Mandibular sites showed a larger amount of bone graft resorption than maxillary sites without major complications at donor or recipient sites. All the 40 implants placed were well integrated. Authors concluded that from a clinical point of view augmentation procedure appears to be simple, safe and effective for treating localized alveolar ridge defects in partially edentulous patients.

Fiorellini & Nevins in (2003)[27] conducted a descriptive statistics analysis to evaluate dental implant survival rates in patients treated with ridge

augmentation or preservation techniques. Result of the study indicated high level of predictable implant survival in sites treated by GBR or preservation techniques. These survival rates are similar to those of implants placed in native bone. Based on the results of these studies it is clear that implants placed in regenerated bone are just as successful as those placed in native bone.

Fabrizio Bravi et al (2007)[25] in a Multicenter Retrospective Clinical Study work evaluated the data gathered over a period of 10 years on implants placed with the edentulous ridge expansion (ERE) technique. 1,715 consecutive implants were placed with the ERE technique by using a common surgical protocol. The implants were followed up using a common protocol and a specific database for the collection of clinical information on the patient, surgery, and follow-up, including the 1986 Albrektsson et al criteria for implant success. All data gathered at the end of the study period were placed in a common database. The overall success rate over the 10-year follow-up period was 95.7%.

Uchida et al (2008)[82] in a clinical case report presented a new technique for reconstructing the vertical and horizontal dimensions of the alveolar ridge using a mandibular bone block at sites planned for single implants. The author extracted the periodontally hopeless tooth and the alveolar ridge was augmented using the autogenous graft harvested from

retromolar area. After six months of treatment, approximately 7 mm of horizontal and 3 mm of vertical augmentation were gained.

The gain in the vertical and horizontal dimensions was sufficient for placing an implant in an optimal position and allowed an esthetic result with a single-tooth crown

Giuseppe Corinaldesi et al (2009)[34] reported a retrospective longitudinal study in which he evaluated the survival and success rates of 56 implants consecutively placed in alveolar ridges following a one or two stage augmentative procedure using autogenous bone for which follow up data were collected after 3-8 years of prosthetic loading. none of the 56 implants was lost during the observation period. Cumulative implant survival rate was 100%.

MATERIAL AND METHODS

STUDY DESIGN

Nine patients selected from the Outpatient Department of Periodontics, Ragas Dental College & Hospital, Chennai, participated in this clinical trial for horizontal ridge augmentation using corticocancellous block autograft prior to two stage implant placement. These patients exhibited **Misch** and **Judy in (1987)**[58] division B ridge defect, with single missing tooth and residual alveolar ridge width of 3-5mm with no or minimal vertical ridge loss. All these patients were assessed radiographically using spiral computerized tomogram measurements over 6 months and followed.

Patients were assessed preoperatively and reassessed post-operatively for radiographic parameters using spiral Computer Tomography scan at baseline and 6 months time interval. Clinical examinations were performed at follow-up visits to check for complications including infection, inflammation, wound dehiscence and resorption.

The clinical outcome of the treatment were assessed using the following parameters

1. Mean width of the keratinized gingiva was measured using a William periodontal probe at baseline and 6 months.[11]
2. Spiral CT scan measurements of ridge width pre and postoperatively. The change in the horizontal dimension buccolingually.

- At the crest
- 2mm from the crest
- 4mm from the crest

3. Radiographic assessments was done to measure the changes in the vertical bone dimension apicocoronally at baseline till 6 months using OPG.

PATIENT SELECTION

Nine systemically healthy patients (9 males) in the age group of 20 - 40 years, who were deemed from implant placement because of insufficient ridge volume referred to the Outpatient Department of Periodontics, Ragas Dental College, Chennai. All these patients exhibited single missing anterior / posterior edentulous ridge with available bone corresponding to division B (4 to 5 mm of horizontal bone width) and vertical bone height of ≥10mm according to **Misch** and **Judy (1985)**[58] and ≤ 3mm from the CEJ of adjacent tooth to the crest of the bone.

Inclusion Criteria:

1. No active periodontal disease present.
2. Single edentulous ridge present in the anterior/ posterior of the maxilla/mandible.
3. The bone crest to CEJ of adjacent tooth distance ≤3mm.

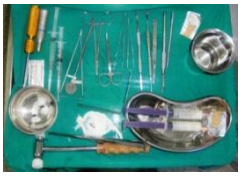
4. Residual vertical bone height at the edentulous site to place ≥10mm implant.
5. A residual horizontal bone width corresponding to division B (Misch& Judy).[58]
6. No caries or periapical pathology on the adjacent tooth to the edentulous site.

Exclusion Criteria:

1. Pt with known risk factor and risk modifier were excluded.
2. Pregnant and lactating women were excluded.
3. History of known allergy to medications.
4. Any Systemic factor that interfere with the treatment and the outcome of the therapy.
5. Chemotherapy or radiation therapy.

Written consent was obtained from each patient prior to his or her inclusion into this study and followed for 6 months.

ARMAMENTARIUM



- Mouth mirror.
- William's periodontal probe with marking of 10mm.
- Standard vernier caliper (marking 0-15 mm).
- Tweezers.
- 2 ml disposable syringes (unilock).
- Dappen dish – 2 Nos.
- Kidney trays – 1 No.
- 20 ml saline irrigation syringes – 3 Nos.
- Normal physiological saline 500ml bottles (0.9%W/V).
- 0.2% ChlorhexidineMouthrinse.
- Disposable suction tips.
- 2% lignocaine hydrochloride with 1:80000 adrenaline.
- Bard Parker handle No. 3 – 1 No.
- Bard Parker blade No.15.-2 N0s.
- Austin's Cheek Retractor.

- Tungsten carbide bur- No 701.
- Periosteal elevator.
- Surgical curettes.
- Curved Goldman fox scissors.
- Tissue Holding forceps.
- Bone screw driver kit (SirajSurgicals ™).
- Airmotor Handpieces.
- Cross cut fissure bur size 1.
- Needle holder -1 no.
- 3-0 Mersilk non - absorbable sutures.
- Micromotor hand piece.
- Vicrylresorbable suture.
- Titanium screw 1.5 X 10mm &1.5 X 8mm.
- Adin implant system with implants.

CLINICAL PARAMETERS

All Clinical data regarding of hard and soft tissue dimensions at the augmented sites were recorded at each visit by one calibrated examiner. Soft tissue measurements were made to the nearest 0.5mm using a Williams's periodontal probe.

Clinical Measurements

Soft tissue measurement

The following soft tissue measurements were taken at baseline and 6 months.

1. **Width of the attached gingiva-in (mm).**

   Width of attached gingiva – cemento enamel junction of the adjacent teeth to the mucogingival was measured at three regions, mesial, mid buccal and distal of the edentulous site and mean width of the keratinized gingiva was calculated during baseline, and 6 month period.

Hard tissue measurement

(1) Radiographic measurements

Radiographic examinations of all the patients were performed at the edentulous sites preoperatively and post operatively using a spiral computer tomography. The following measurements were performed

for evaluation of the residual bone quantity. Spiral computer tomography slicing were done in the range of 0.4mm.

Horizontal dimension of the edentulous region at various position of the ridge was calculated using multiple splice section at the region of edentulous site.

(1) at the crest,

(2) 2mm from the crest

(3) 4 mm from the crest

(2) **Radiographic changes in the vertical bone height at different time interval.**

Orthopantomograph radiographs were taken pre operatively and post operatively to assess the vertical bone loss after augmentation procedure. In the radiographs edentulous space alveolar crest was marked, vertical lines were drawn parallel to the adjacent teeth marking point A and point B. CEJ of the adjacent teeth were connected, mid point of point A and point B was marked as point C which connected the mid point of CEJ and the alveolar crest. The mean value of the crestal bone changes were calculated at the baseline and 6 months.

SURGICAL PROCEDURE

An informed written consent was obtained from the patient who underwent the surgery. Surgery was carried out under aseptic sterile condition. The patients preoperatively rinsed with 10ml of 0.2% chlorhexidine mouthwash.

Recipient site:

Local anesthesia with Lignocaine Hydrochloride 2% with adrenaline 1: 80,000 was administered at the recipient site. The initial crestal incision slightly lingual/palatal in the keratinized mucosa was placed and the incision was continued intra sulcularly one tooth mesial and distal to the edentulous site. Full thickness mucoperiosteal flap was elevated to gain access into the ridge defect.

Donor site:

The symphysis area was exposed by a vestibular incision in the canine to canine region. A full thickness mucosal flap was reflected to the inferior border, which results in a degloving of the anterior mandible and allows for good visualization of the entire symphysis. Subsequently the dimension of the graft was determined considering the size of the ridge defect at the implantation site. A 5mm safety margin was allowed inferior to the apices and superior to the lower border of the mandible. The bone graft was outlined with a round surgical bur below the apices of the incisors either on the right /left

side to the midline of the symphysis region and the resulting osteotomy were connected with a fissured bur or osteotome. The grafts were trimmed appropriately toensure ideal adaptation to the recipient site, A low-speed round bur was used to perforate the block with 1.5mm osteotomes the same diameter as the tag screw for proper stabilization to take place.

After removal of the corticocancellous block with a bone chisel, additional bone was harvested with bone curettes from the caudal site. The harvested bone was preserved in a cold saline solution prior to soft tissue closure of the mandibular donor site, the area was copiously irrigated and inspected. Sharp osseous edges, irregularitieswere reduced to minimize post operative discomfort and bleeding spots were arrested with the use of minimal amount of bone wax.

Closure of the site was performed with bilayer suturing technique the mentalis muscle was first sutured with periosteum using vicryl sutures and then the vestibule was sutured with the mucogingival junction using 3 – 0 mersilk sutures to minimize the post operative discomfort.

After harvesting the autologous corticocancellous graft were fixed with titanium screw with diameter of 1.5mm x 10mm and 8mm length to the alveolar bone at the future implant site. Particulate autogenous bone was packed around the fixed block graft and the flap was approximated and sutured with 3-0 mersilk.

POST OPERATIVE CARE:

Patients were prescribed post-operative antibiotics and analgesic, Amoxycillin 500mg one tablet thrice daily for 7 days and ibuprofen 400mg twice daily for 3 day. Patients were instructed to use external icepack for 3 hours intermittently and a soft diet for the first few weeks and avoidance of stretching the surgical area. Patients were instructed to limit tooth brushing at the surgical site. Chemical plaque control with 10 ml of 0.2% chlorhexidine rinse for 10 days was instructed. Sutures were removed after two weeks.

RECALL VISITS:

Of the nine patients who underwent horizontal ridge augumentation, graft rejection was reported in two casesbetween 3 to 6 months interval. Patients were recalled at the end of first month, third month and sixth month time interval. The mean width of the keratinized gingiva was calculated at the baseline and sixth month interval. Hard and soft tissue measurements were recorded and tabulated at the sixth month. Post operative soft tissue healing was evaluated at 1 month time period, all patients who participated showed uneventful healing.

SURGICAL RE-ENTRY:

Surgical re-entry for implant placement at the augmented sites was carried out at the end of the sixth month. Local anesthesia was administered with 2% Lignocaine hydrochloride in 1: 80,000 adrenaline. Crestal incisions with extending crevicular incisions on two teeth on either side of the

edentulous sites were placed. Full thickness mucoperiosteal flap was reflected and the augmented underlying bone was visualized and new ridge dimension was recorded using a standard vernier calliper at the crest, 2 mm from the crest, 4 mm from the crest. Titanium screws were removed from the autograft.

Out of the nine patients endosseous implants were subsequently placed in 2 patients in the augmented site according to the ridge width and the height and the flaps were approximated and sutured with 3-0 Mersilk non-resorbable sutures and the patients were followed.

PROTOCOL

Name: Age/Sex:

Address: Date:

Phone No:

Chief Complaint:

History of Chief Complaint:

Past Dental History:

Past Medical History:

Edentulous Site:

TABLE 1.

MEAN WIDTH OF KERATINIZED GINGIVA AT SITES OF AUGMENTATION AT DIFFERENT TIME INTERVALS

S. No.	Baseline (mm)	6 Months (mm)
1		
2		
3		
4		
5		
6		
7		
8		
9		

TABLE 2.

CHANGES IN THE HORIZONTAL RIDGE DIMENSION USING SPIRAL CT ANALYSIS AT DIFFERENT TIME INTERVALS

S. No.	Baseline			6 Months		
	At the crest (mm)	2mm from the crest (mm)	4mm from the crest (mm)	At the crest (mm)	2mm from the crest (mm)	4mm from the crest (mm)
1.						
2.						
3.						
4.						
5.						
6.						
7						
8						
9						

TABLE 3.

RADIOGRAPHIC CHANGES IN THE VERTICAL BONE HEIGHT AT DIFFERENT TIME INTERVAL

S. No.	Baseline (mm)	6 Months (mm)
1		
2		
3		
4		
5		
6		
7		
8		
9		

STATEMENT OF INFORMED CONSENT

Patient name: Date:

I have been explained about the nature and purpose of the study in which I have been asked to participate. I understand that, I am free to with draw my consent and discontinue at any time without prejudice to me or effect on my treatment.

I have been given the opportunity to ask questions about the procedure. I have also given consent for taking pre and post operative photographs and CT scans for the study purpose. I have fully agreed to participate in this study.

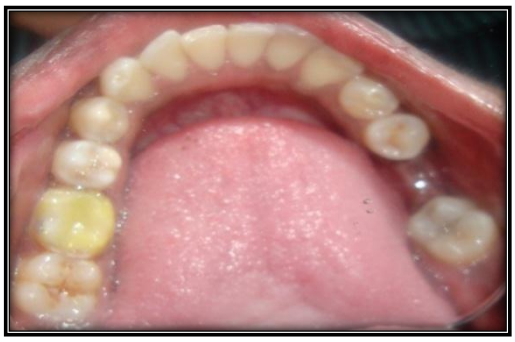
I hereby give consent to be included in the clinical study "Clinical and Radiographic Evaluation of Horizontal Ridge augmentation using Corticocallous block autograft harvested from symphysis" -6 months study.

Signature of the PG Student Signature of the patient

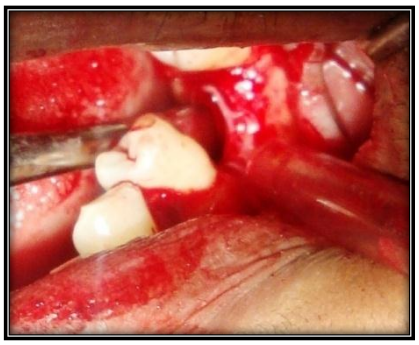
Signature of HOD

CASE #1

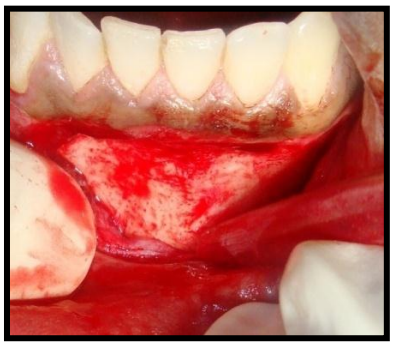
PRE OPERATIVE



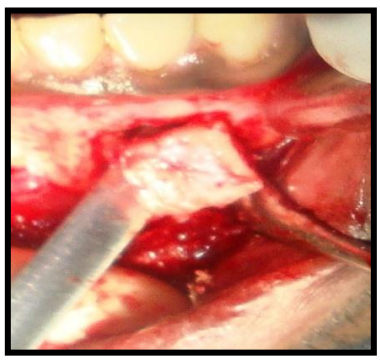
RECIPIENT SITE



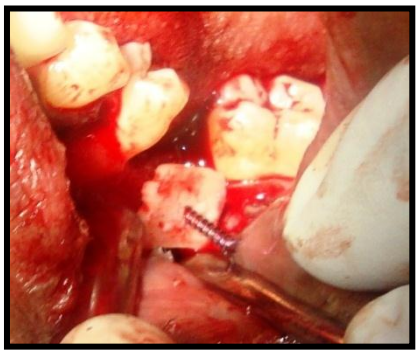
DONOR SITE



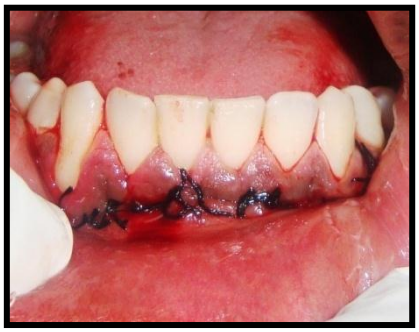
GRAFT HARVESTED



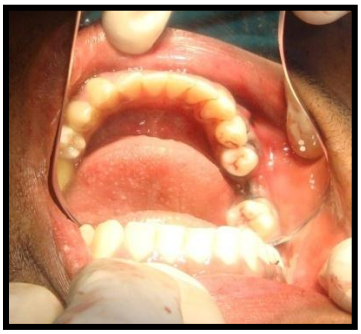
GRAFT STABILIZED WITH TITANIUM SCREW



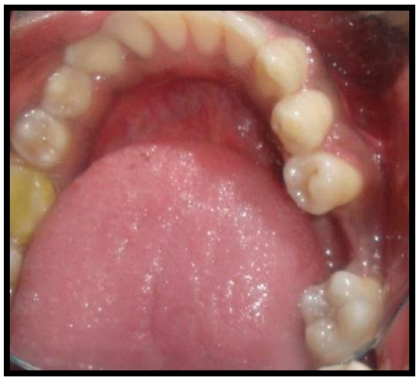
Donor Site Sutured



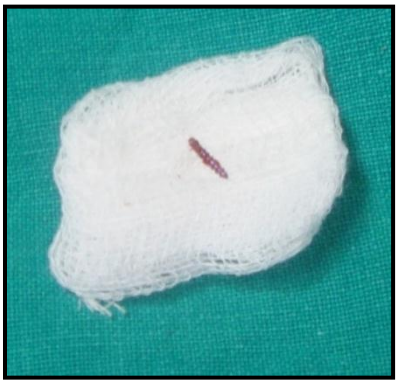
Recipient Site Sutured



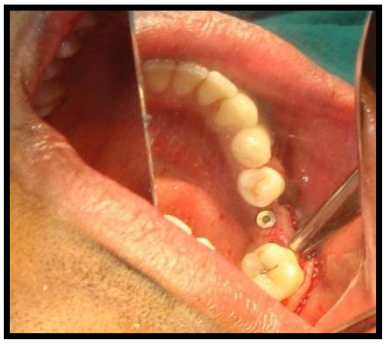
Post Op View At 6 Month



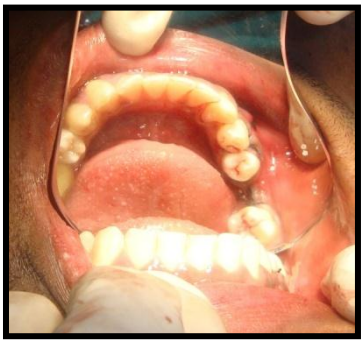
Titanium Tag Screws Removed



Endosseous Implant Placement

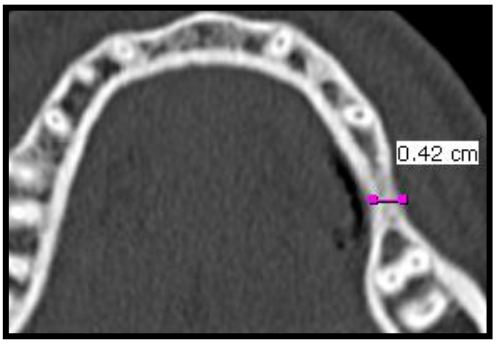


Primary Closure with Sutures

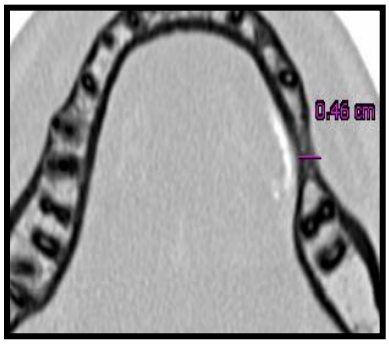


PRE OP SPIRAL CT

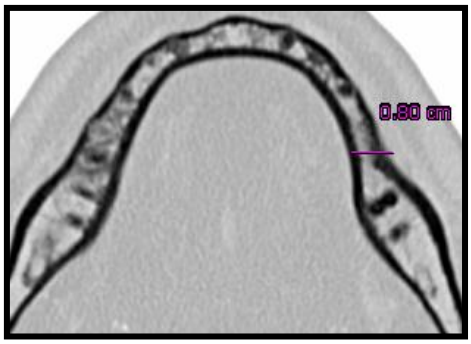
At The Crest



2MM From The Crest

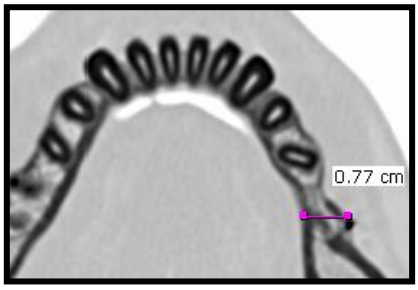


4MM From The Crest

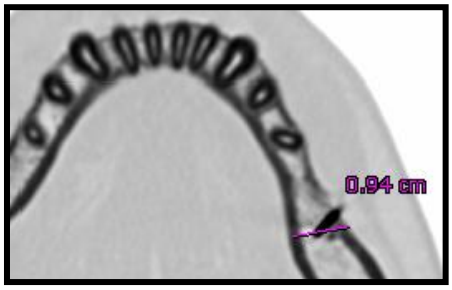


POST OP CT

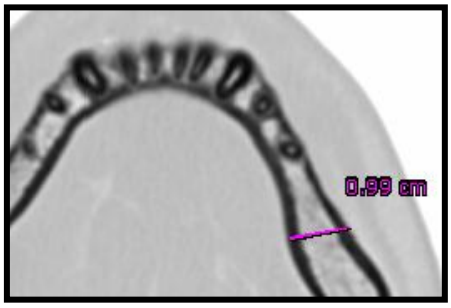
At The Crest



2MM From The Crest

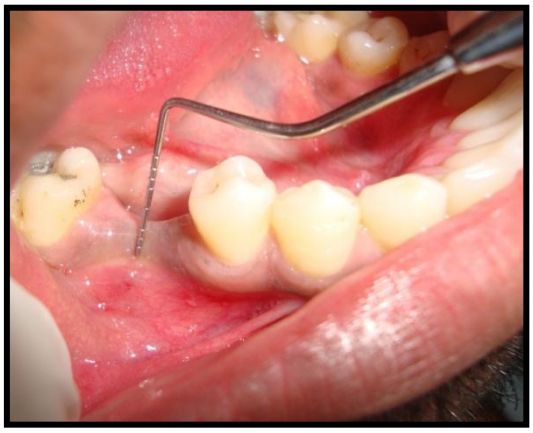


4MM From The Crest

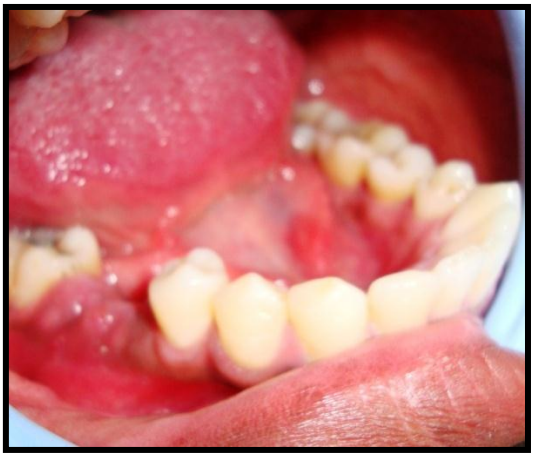


CASE #2

Pre Operative

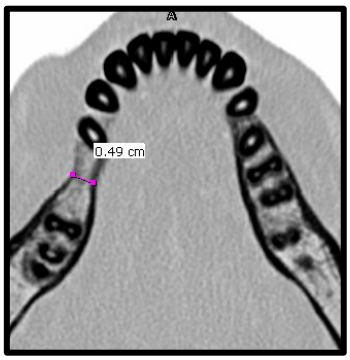


Post Operative

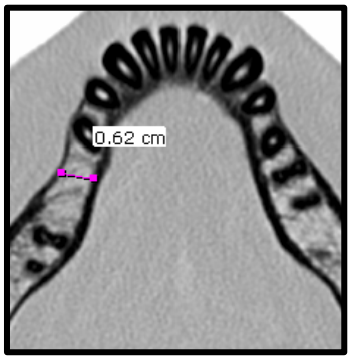


PRE OP CT

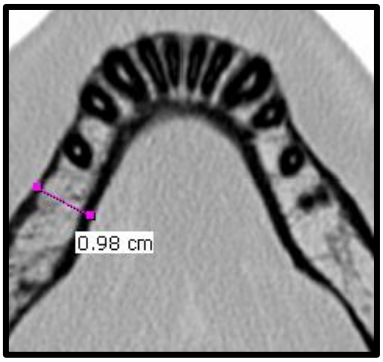
At The Crest



2MM From The Crest

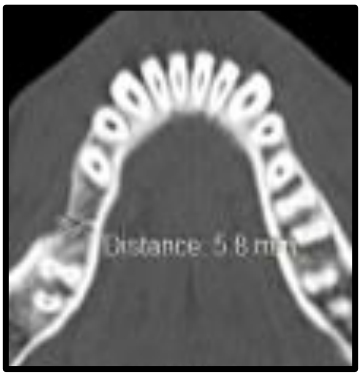


4MM From The Crest

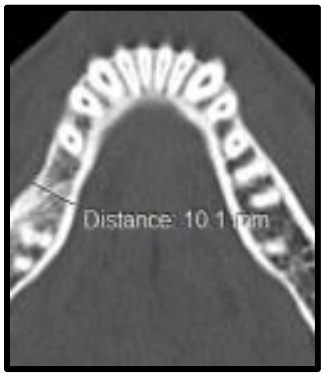


POST OP CT

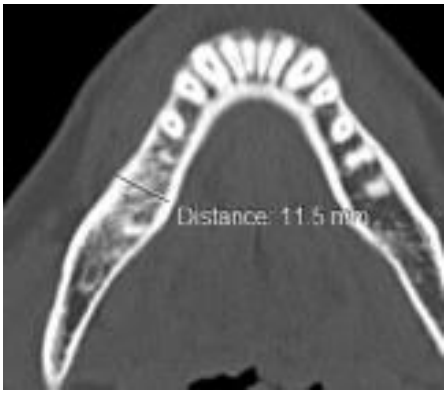
At The Crest



2MM From The Crest

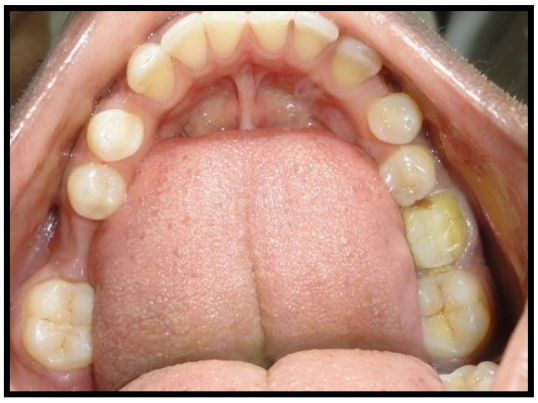


4MM From The Crest

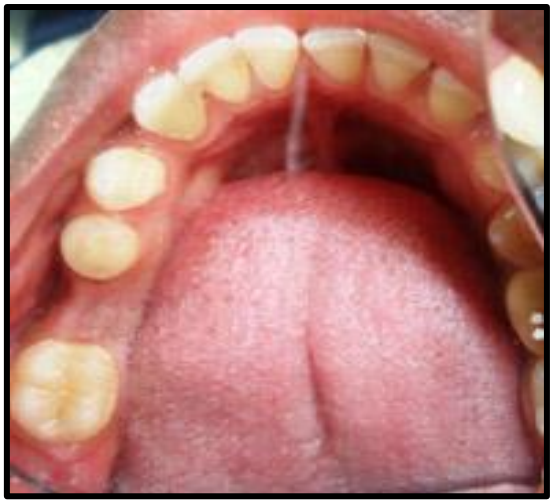


CASE # 3

Pre Operative

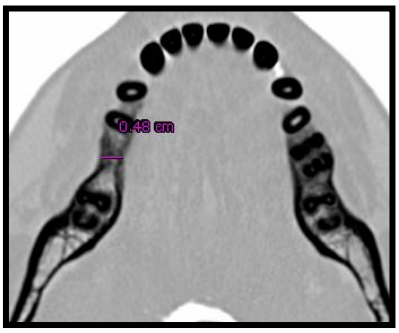


Post Operative

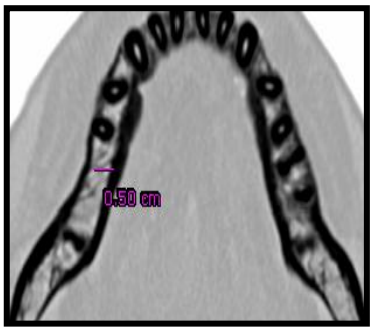


PRE OP CT

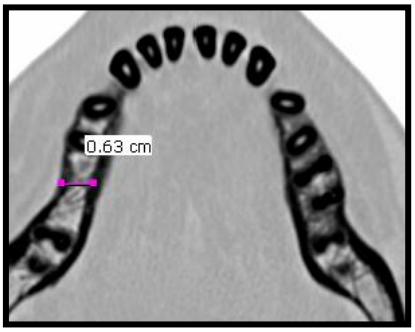
At The Crest



2MM From The Crest

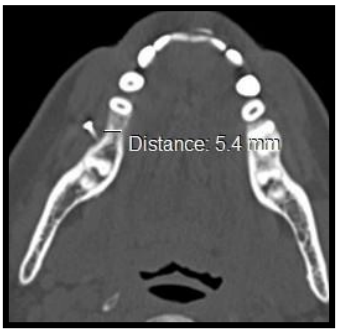


4MM From The Crest

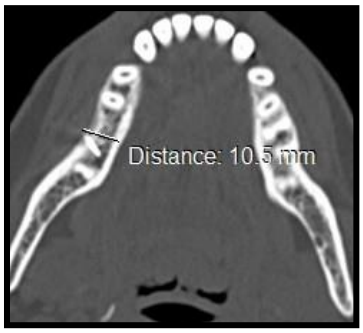


POST OP CT

At The Crest



2MM From Crest



4MM From The Crest

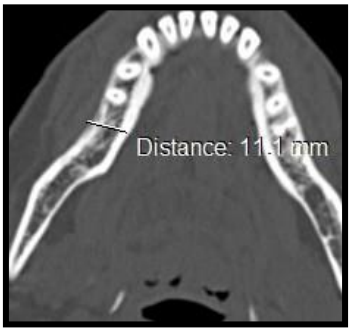


TABLE 1.

MEAN WIDTH OF KERATINIZED GINGIVA AT AUGMENTED SITES AT DIFFERENT TIME INTERVALS

S. No.	Baseline (mm)	6 Months (mm)
1	2mm	2mm
2	3mm	3mm
3	5mm	5mm
4	3mm	3mm
5	4mm	4mm
6	4mm	3mm
7	4mm	4mm
8	3mm	3mm
9	-	-

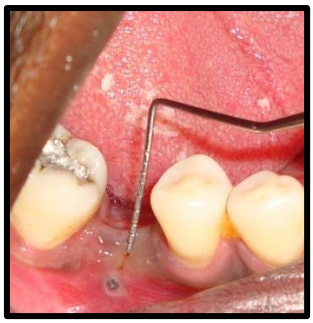


TABLE2.

CHANGES IN THE HORIZONTAL RIDGE DIMENSION USING SPIRAL CT ANALYSIS AT DIFFERENT TIME INTERVALS

S. No.	Baseline			6 Months		
	At the crest (mm)	2 mm from the crest (mm)	4 mm from the crest (mm)	At the crest (mm)	2 mm from the crest (mm)	4mm from the crest (mm)
1.	4.3mm	4.6mm	8.0mm	7.7mm	9.4mm	9.9mm
2.	4.9mm	6.2mm	9.8mm	5.8mm	10.1mm	11.5mm
3.	4.4mm	4.7mm	3.5mm	5.4mm	5.6mm	6.4mm
4.	3.6mm	5.5mm	6.3mm	4.2mm	5.7mm	6.9mm
5.	4.5mm	5.6mm	6.3mm	5.9mm	5.9mm	6.8mm
6.	4.8mm	6.3mm	5.0mm	5.4mm	10.5mm	11.1mm
7	4.7mm	4.2mm	7.1mm	8.9mm	12.2mm	13.0mm
8	4.4mm	4.6mm	6.3mm	5.2mm	5.8mm	9.2mm
9	4.9mm	5.4mm	6.1mm	7.0mm	8.1mm	8.5mm

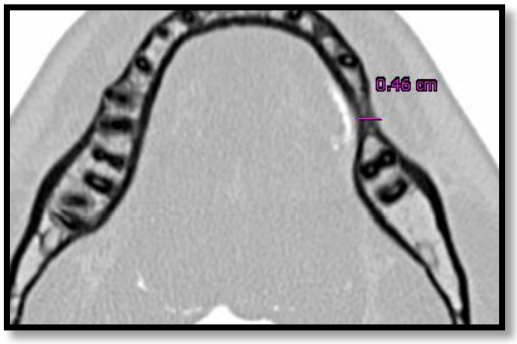
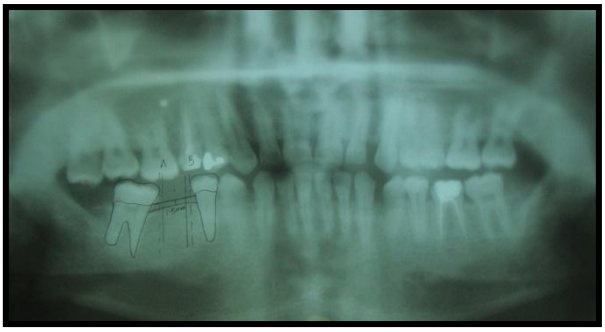
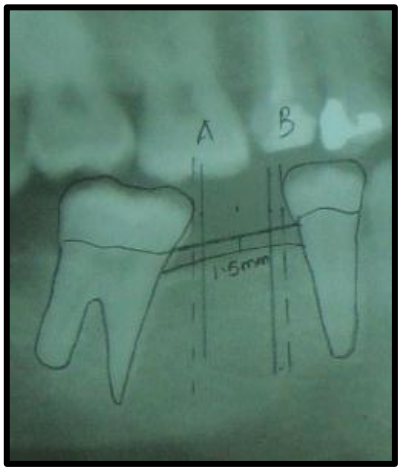


TABLE 3.

RADIOGRAPHIC CHANGES IN THE VERTICAL BONE HEIGHT AT DIFFERENT TIME INTERVAL.

S. No.	Baseline (mm)	6 Months (mm)
1	6mm	6mm
2	3mm	6mm
3	4mm	15mm
4	3mm	4mm
5	5mm	5mm
6	1.5mm	2mm
7	9mm	13mm
8	5mm	6mm
9	7mm	9mm





CLINICAL PARAMETERS:

WIDTH OF KERATINIZED GINGIVA:

The mean value of width of keratinized gingiva at baseline was (3.50mm± SD 0.92mm,) at the end of 6month the value was (3.38mm± SD 0.916mm).There was no significant change in the mean width of keratinized gingiva at different time intervals with a P-value ≥0.05. (Table 1)

RADIOGRAPHIC PARAMETERS

SPIRALCOMPUTER TOMOGRAPHIC MEASUREMENT:

The mean value of horizontal ridge dimensions as calclulated from the sections of the edentulous site at the crest the baseline mean value was (4.5mm ± SD 0.406mm), at 6month interval it was (6.1mm ± SD1.4mm). Similarly at 2mm from the crest the mean value was (5.2mm ± SD 0.746), at 6 month the value was (8.14mm ± SD1.5mm). At 4mm from the crest the horizontal mean value was (6.4mm ± SD1.7mm) and at 6months it was (9.25mm ± SD 2.3mm) comparing the baseline value changes in the horizontal ridge dimension at various positions on the ridge at 6 months interval was statistically significant at 5% level with the P value ≤ 0.05. (Table 2)

OPG MEASUREMENTS:

Radiographic changes in the mean vertical bone height at baseline was (4.8mm ± SD2.2mm) and at 6 month time interval the mean value was (7.3mm

± SD 4.2mm). However there was no statistical difference in the value radiographically. The P value was ≥ 0.05. (Table 3)

STATISTICAL ANALYSIS

Data was expressed as mean ± standard deviation of the parameters evaluated. Clinical and radiographic parameters were recorded at baseline and 6 month post operatively. Comparisons were made within each group between baseline, and 6^{th} month using the paired **T** test.

In the present study p value ≤0.05 was considered as significant at 5% level and P value ≥0.05 was considered as not significant at 5% level.

TABLE 1

MEAN WIDTH OF KERATINIZED GINGIVA AT DIFFERENT TIME INTERVALS

Edentulous site	Mean	SD	P Value
Baseline in mm	3.50	0.926	0.790
6 months in mm	3.38	0.916	

P Value ≥ 0.05 which is not statistically significant at 5% level

TABLE 2

CHANGES IN THE HORIZONTAL RIDGE DIMENSION USING SPIRAL CT ANALYSIS AT DIFFERENT TIME INTERVALS

Edentulous sites	Baseline		6 months		P Value
	Mean	SD	Mean	SD	
At the Crest	4.50	0.40	6.16	1.44	0.004*
2 mm from the crest	5.23	0.74	8.14	2.50	0.004*
4 mm from the crest	6.48	1.76	9.25	2.32	0.012*

P value ≤ 0.05 at the crest, at 2mm and 4mm from the crest which is statistically significant at 5% level.

TABLE 3

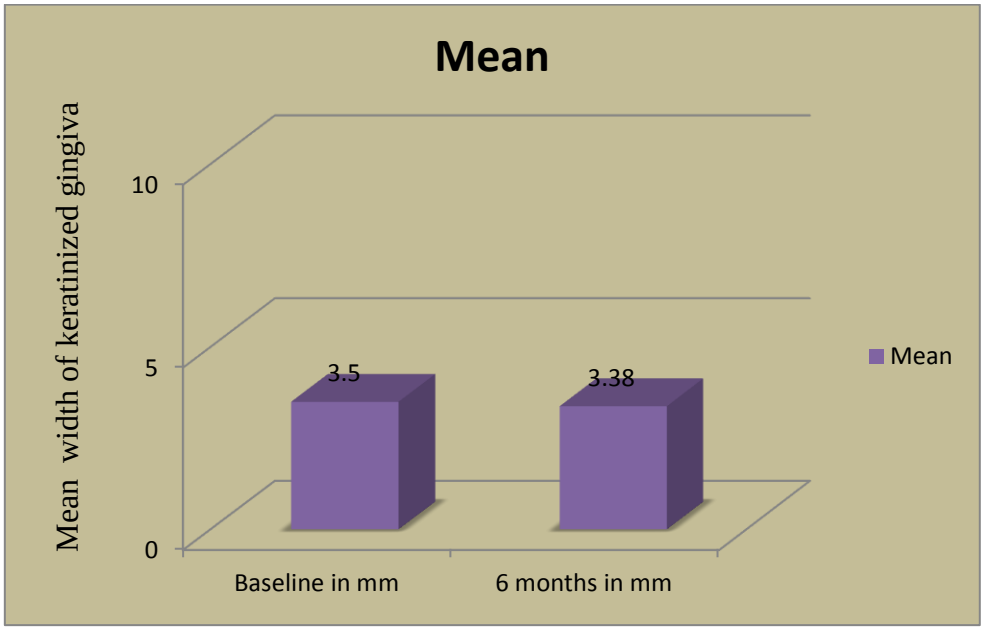
RADIOGRAPHIC CHANGES IN THE VERTICAL BONE HEIGHT AT DIFFERENT TIME INTERVAL

Edentulous site	Mean	SD	P Value
Baseline in mm	4.83	2.29	0.139
6 months in mm	7.33	4.24	

P Value ≥ 0.05 which is not statistically significant at 5% level

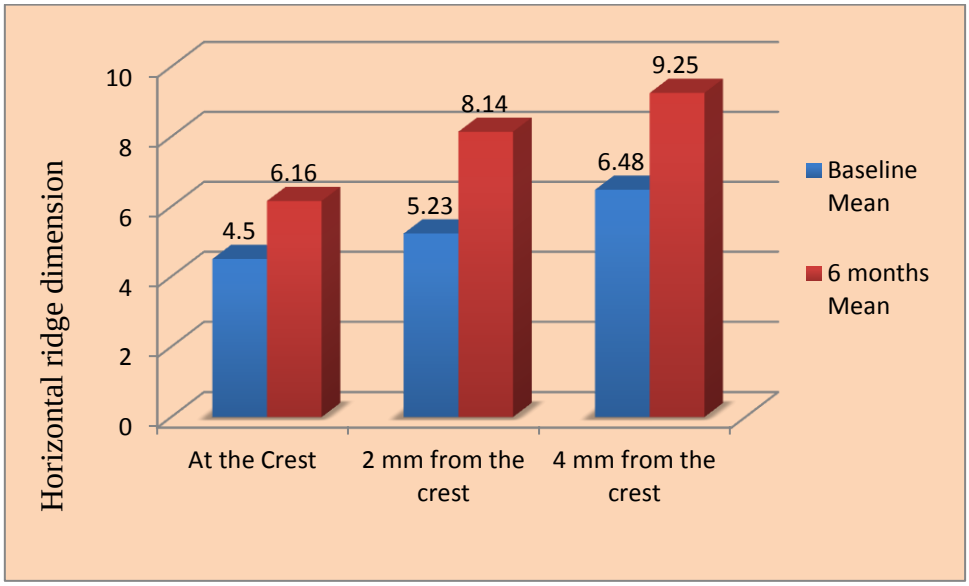
GRAPH-1.

MEAN WIDTH OF KERATINIZED GINGIVA AT DIFFERENT TIME INTERVALS



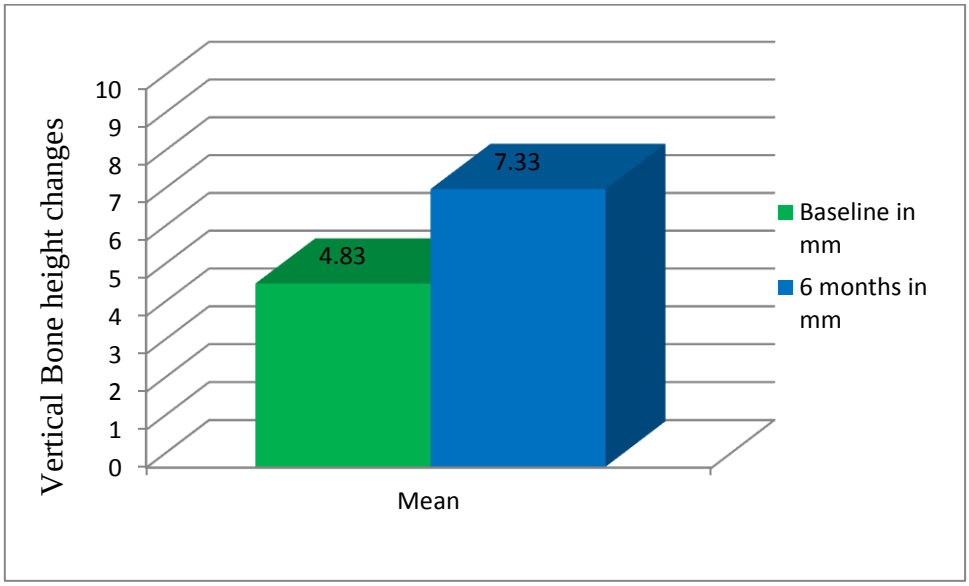
GRAPH 2:

CHANGES IN THE HORIZONTAL RIDGE DIMENSION USING SPIRAL CT ANALYSIS AT DIFFERENT TIME INTERVALS



GRAPH 3:

RADIOGRAPHIC CHANGES IN THE VERTICAL BONE HEIGHT AT DIFFERENT TIME INTERVAL



DISCUSSION

Reconstruction of residual alveolar ridge defect is a prerequisite prior to implant placement. Theaccelerated amount of alveolar bone loss result in residual ridge resorption greater than 60% at the end of first year. Autogenous bone grafts are preferred material of choice for ridge augmentation procedure prior to implant placement because of its osteogenicproperties.[87]

Corticocancellous block grafts harvested from the symphysis region can be used to augment horizontal and vertical deficiencies upto 6mm of ridge dimension.[70] The average thickness of this corticocancellous graft is 3 to 11mm, with an dimension of 5 to 8mm.(LXW).[70] The advantage of symphyseal corticocancellous block graft is their convenient surgical access.[31] Literature review have show that corticocancellous block graft from the mandibular region undergo less resorption compared to the endochondral bone like the iliac block graft**.**[75] when augmenting site for implant placement, it is necessary that the recipient sites have a good bone density in the range of D1 and D2 for better implant stability and loading.[70] Henceforth it can be put forward that autogenous corticocancellous bone grafts are the gold standard for bone augmentation procedure compared to other materials.[94]

Keeping in this frame work thepresent study was undertaken to evaluate the clinical outcome of sites which undergoes corticocancellous block graft ridge augmentation prior to endosseous implant placement by computer

tomographic method. Spiral computer tomography offers an better advantages to other diagnostic imaging modalities because of its ability to interpret the region of interest at different axial planes and multiple slice imaging of different thickness ranging from 1-5mm at the region of interest and can be obtained.[57]

In the present clinical and radiographic study 9 healthy individuals with horizontal ridge deficiency of 4-5mm, who required augmentation with corticocancellous block graft prior to implant placement was followed up over a 6 month period. Autogenous corticocancellous bone graft obtained from the symphysis region were used for the purpose of ridge augmentation.

All the participants in the present study were evaluated for soft tissue parameter and hard tissue changes at baseline and 6 month interval.

Soft tissue changes in terms of Width of keratinized tissue. (mm)

Hardtissue changes at the augmented site were evaluated at baseline and 6 months for mean change in horizontal dimension of the ridge and also mean change in the vertical dimension of the ridge from the crest at the augmented sites were evaluated.

The mean width of keratinized gingiva at baseline was (3.50mm± SD 0.92mm), at the end of 6month the value was (3.38mm± SD 0.916mm). When this value was subjected to statistical analysis there was no statistical difference with a P value $\geq$ 0.05. It can be attributed that there was

nodimension changes in keratinized tissue around the augmented site. This was in accordance to the earlier studies done by **Scharf et al** and **Batista et al.**[77,23]

During the enrolment out of the 9 subjects 8subjectsin the present study had adequate zone of keratinized tissue at baseline. With a mean dimension of greater than 3mm. Studies have shown that keratinized tissue at the edentulous site is necessary for tension free closure during augmentation, implant placement procedure and also this keratinised tissue acts as a soft tissue barrier around the implant collar during functional loading and long term maintenance.[45,46]

Spiral computer tomography offers a more accurate measurement of the changes in the residual ridge dimension.[71] In the present study spiral computer tomography measurements were usedto measure the mean changes in the ridge dimension at augmented sites. Spiral computer tomography measurements were performed for the mean horizontal tissue dimension at the 3 site of interest

- at the crest,
- 2mm from the crest
- 4mm from the crest.

At the crest the mean value was (4.5mm ± SD 0.406mm), at 6 month interval it was (6.1mm ± SD1.4mm). Similarly at 2mm from the crest the mean

value was (5.2mm ± SD 0.746), at 6 month the value was (8.14mm ± SD 1.5mm). When this value was subjected to statistical analysis both value (at the crest and 2mm from the crest) the Pvalue was ≤ 0.05, which was statistically **significant**. The overall mean average increase in horizontal dimension at the augmented site at the end of 6 month was at crest 1.6mm and at 2mm from the crest at 6month was 2.9mm respectively.

Similarly at 4mm from the crest the horizontal mean value changes in the ridge dimension at baseline was (6.4mm ± SD 1.7mm) and at 6 months it was (9.25mm ±SD 2.3mm) when this value was subjected to statistical analysis the P value was ≤ 0.05which was statistically **significant**. The mean average increase in the dimension at 4mm from the crest was found to be 2.8mm at 6 months interval.

In the present study 4 subjects underwent augmentation in the maxillary anterior region and 5 subjects underwent augmentation in the mandibular posterior region. From the clinical and tomographic interpretation all the subjects showed increased resorption of the corticocancellous block graft at the site of augmentation and theses phenomena was more pronounced in the maxillary anterior region to that of the mandibular posterior region,it can be interpreted to the following reason in the present since there were no barrier membrane used to secure the block graft, no particulate graft were used fill the dead space between the graft and the native bone and in term of stabilization minimal number of retentiontitanium screw were used because of

the limited available size corticocancellous block graft and there may have been a micro movement during the healing phase all these factor may have contributed the result of the present study which were in accordance to previous studies done by **Buser et al**, **Fonseca et al**, **Lundgren et al**, **Jovanovic et al**, **proussaefs et al**.[16,52,72]

Orthopantomograph radiographs were taken pre operatively and post operatively to assess the vertical bone loss at augmented sites. Radiographic changesin the mean vertical bone height at baseline was (4.8mm ± SD 2.2mm) and at 6 month time interval the mean value was (7.3mm ± SD 4.2mm). when subjected to statistical analysis it was not significant. The P value was ≥ 0.05. However there was no statistical difference in the value radiographically

Even though the mean values were not statistically significant, in the radiographic and clinical point of view the majority of the subjects showed vertical changes in the dimension at the end of 6 months time period. The degree of vertical hard tissue changes were pronounced in the maxillary anterior subjects to that of the mandibular posterior subjects. The reason for such changes can be due to the difference in the quality of the native bone. And the second reason may be the native bone is devoid of periosteal flap in the recipient site which leads to decreased vascularisation and might have results in excessive resorption of the crestal alveolar bone which is in accordance to the results of the present study.

Corticocancellous block autograft harvested from the symphysis proved to be successful therapeutic modality in treating **Misch** and **Judy**[58] division B ridge deficiency of 4-5mm residual alveolar ridge. However the number of patients and the duration of the present study is inconclusive. Hence long term control clinical trials and radiographic studies are needed to validate the augmented results.

SUMMARY AND CONCLUSION

The present study elucidated a clinical and spiral Computer Tomographic evaluation of horizontal ridge augmentation with corticocancellous block autograft. The study population comprised of 9 patients (9 males) with age ranging from 20-40 yrs. All 9 patients returned for scheduled recall visits. A total of 9 edentulous sites with Misch and Judy division B ridge defects were treated with a corticocancellous block autograft harvested from the symphysis region. The post operative healing in the grafted areas was satisfactory except two patient reported rejection of the graft. The loose tag screws were removed and patients were motivated for prosthesis.

The following clinical parameters namely width of keratinized gingiva, spiral Computer Tomography to evaluate the horizontal ridge dimension at baseline and 6 months time interval and radiographic changes in the vertical bone height at baseline and 6 months was recorded.

Within the framework of this study, the following conclusions have been elucidated:-

1. Clinical measurements of the mean width of keratinized gingiva did not show any difference from the baseline to 6 months period of the study.

2. Spiral Computer Tomographic analysis exhibited an average increase of 1.6 mm at the crest level, 2.9mm at 2mm level from the crest and 2.8mm at 4mm from the crest level 6 months post operatively.
3. Radiographic changes at the mean vertical bone height showed 2.5mm vertical bone loss at 6 months.

The results presented here clearly demonstrate that Corticocancellous block autograft harvested from the symphysis region was used for augmentation of Misch and Judy division B ridge deficiency yielded favourable clinical outcome. However the results of the present study did not have a very high predictable outcome in terms of the material used. Hence it is necessary to have a large sample size and long term controlled clinical trials to evaluate the true efficacy of this procedure.

FUTURE OUTLOOK

Further developments in bone augmentation should not be technique sensitive or invasive and should be a single stage procedure. Synthetic material could result in lower surgical risk when compared to autogenous block graft. New material developed should be of a matrix with cell ingrowth capacity which could influence the biologic principles providing space for tissue regeneration. The material should be less technique sensitive & a single stage procedure with predictable bone augmentation.

BIBLIOGRAPHY

1. **Adell R, Erikkaon B, Lekholm U, Branemark P-I.** Long term follow-up study of osseointegrated implants in the treatment of totally edentulous jaws. Int J Oral Maxillofac Implants 1990;5:347-359.
2. **Allen EA, Gainza CS, Farthing GG, et al DA.** Improved technique for localized ridge augmentation. J Periodontol 1985;56:195-199.
3. **Andersson B, Odman P, Lindvall AM, Lithner B.** Single-tooth restorations supported by osseointegrated implants: Results and experiences from a prospective study after 2 to 3 years. Int J Oral Maxillofac Implants 1995;10:702-711.
4. **Antoun H, Sitbon JM, Martinez H, Missika P**. A prospective randomized study comparing two techniques of bone augmentation: onlay graft alone or associated with a membrane Clin. Oral Impl. Res. 2001;12:632–639.
5. **Araujo MG, Lindhe J.** Dimensional ridge alteration following tooth extraction. An experimental study in the dog. J. Clin Periodontol 2005;32:212-218.
6. **Arun K. Garg**. Biology, Harvesting, Grafting for Dental Implants. Quintesscence International.
7. **Atwood DA:** Some clinical factors related to the rate of resorption of residual ridges, J Prosthet Dent 1971;12:441-450.

8. **Bahat O, Fontanesi RV, Preston J.** Reconstruction of the hard and soft tissues for optimal placement of osseointegrated implants. Int J Periodonics Restorative Dent 1993;13:255-275.
9. **Bahr W, Coulon JP 1996** studied the limits of mandibular symphysis as a donor site for bone grafts in early secondary cleft palate osteoplasty int j oral maxillofac surg 1996;25:389.
10. **Balaji SM**. Management of deficient anterior maxillary alveolus with mandibular parasymphyseal bone graft for implants. Implant Dentistry 2002;11:363-369.
11. **Barry I Simon, Stanley Von Hagen, Michael J. Deasy, Mitesh Faldu and, Dasha Resnansky:** Changes in the alveolar bone height and width following ridge augmentation using bone graft and membrane. Jp 2000;71:1774-1791.
12. **Bassett CA, Creighton DK & Stinchfield FE.** Contributions of endosteum, cortex and soft tissues to osteogenesis. Surg Gynecol Obstet 1961;112–145.
13. **Borstlap WA. Heidbuchei KLWN. Freihofer HPM.** Early secondary bone grafting of alveolar cleft defects: A comparison study between chin and rib grafts.
14. **Boyne PJ, Milkels TE.** Restoration of alveolar ridges by intramandibular transposition osseous grafting. J Oral Surg. 1968;26 (9):569-576.

15. **Bradely S, Mc Allister & Kamran Haghighat.** Bone augmentation techniques. J Periodontol 2007;78;377-396.
16. **Buser D, Bragger U, Lang NP&Nyman S** Regeneration and enlargement of jaw bone using guided tissue regeneration. Clinical Oral Implants Research. I 1990;22-32.
17. **Buser D, Duio K, Beiser U, Hirt HR Berthoid H.** Locolized ridge augmentation using guided bone regeneration, II. Surgical procedure in the mandible. Int J Periodont Rest Dent 1995;15:11-29.
18. **Carlsson GE, Thilander H. Hedegard. B**, Histologic changes in the upper alveolar process after extraction with or without insertion of an immediate full denture. Acta odontol scand 1967;25:21-43.
19. **Cordaro L, Amade DS, Cordaro M.** Clinical results of alveolar ridge augmentation with mandibular block bone grafts in partially edentulous patients prior to implant placement. Clin Oral Impl Res 2002;13:103–111.
20. **De Andrade E, Otomo Corgel J, Pucher J, Ranganath KA, St George N Jr.** The intraosseous course of the mandibular incisive nerve in the mandibular symphysis. Int J Periodontics Restorative Dent 2001;21:591-597.
21. **Devorah Schwartz-Arad* and Liran Levin** :Symphysis Revisited: Clinical and Histologic Evaluation of Newly Formed Bone and Reharvesting Potential of Previously Used Symphysial Donor Sites for Onlay Bone Grafting J Periodontol 2005;80:865-869.

22. **Edward B. Fowler, Lawrence G. Breault, George Rebitski.** Ridge preservation utilizing an acellular dermal allograft and demineralized freeze-fried bone allograft: Part II. Immediate Endosseous Implant Placement. J Periodontol 2000;71:1360-1364.

23. **Eraldo L. Batista,** Management of soft tissue ridge deformities with acellular dermal matrix. Clinical approach and outcome after 6 months of treatment, J Periodontol 2001;72:265-273.

24. **Eufinger H, Konig S, Machtens E.** Significance of the height and width of the alveolar ridge in implantology in the edentulous maxilla. Analysis of 95 cadaver jaws and 24 consecutive patients (in German). Mund KieferGesichtschir (suppl 1): S14-S18

25. **Fabrizio Bravi, Giovanni B. Bruschi, Francesco Ferrini,** A 10-year Multicenter Retrospective Clinical Study of 1,715 Implants Placed with the Edentulous Ridge Expansion Technique; International Journal of Periodontics & Restorative Dentistry 2007;27:557–565.

26. **Fernando Verdugo, Krikor Simonian, Antonio D'Addona, Jose´ Ponto´ n, and Hessam Nowzari:** Human Bone Repair After Mandibular Symphysis Block Harvesting: A Clinical and Tomographic Study J Periodontol 2010;81:702-709.

27. **Fiorellini & Nevins, 2003.** Localized Ridge Augmentation / Preservation. A Systematic Review 2003;8(1):321-327.

28. **Fritz. ME, Jeffcoat MK, Reddy M.** Implants in regenerated bone in a primate model. J. Periodontol 2001;72(6);703-708.
29. **Fugazzoto PA.** GBR using bovine bone matrix and resorbable and non-resorbable membranes. Part I: Histologic results. Int J Periodontics Restorative Dent. 2003;23(4):361-9.
30. **Fukuda M, Takahashi T, Yamaguchi T**. Bone grafting to increase interdental alveolar bone height for placement of an implant. British journal of Oral and Maxillofacial surgery 2000;38:16-18.
31. **Gerry M. Raghoebar, Leo Meijndert, Wouter W. I. Kalk, Arjan Vissink.** Morbidity of Mandibular Bone Harvesting: A comparative study. Int J Oral Maxillofac Implants 2007;22:359-365.
32. **Giacomo Urbani, Giorgio Lombardo, Enrioo Santi, Dennis Jarnow,** Localized Ridge Augmentation with Chin Gratts and Resorbabie Pins: Case Reports int J Periodont Rest Dent 1998;18:363-375.
33. **Giuseppe Corinaldesi, Francesco Pieri, Claudio Marchetti**. Histologic and histomorphometric evaluation of alveolar ridge augmentation using bone graft and titanium micromesh in humans. J Periodontol 2007;78:1477-1484.
34. **Giuseppe corinaldesi, Licia Sapigni, Claudio Marchetti,** :Evaluation of survival and success rates of dental implants placed at the time of or after alveolar ridge augmentation with an autogenous mandibular bone

graft and titanium mesh: A 3 to 8 years retrospective study. Int J.Maxillofac Implants 2009; 24:1119-1128.

35. **Goldberg V, Stevenson S.** Natural history of autografts and allografts. Clin Orthop Related Res 1987;22:7-16.

36. **Hadi Antoun Jean Max Sitbon Henri Martinez Patrick Missika :**A prospective randomized study comparing two techniques of bone augmentation: onlay graft alone or associated with a membrane Clin. Oral Impl. Res. 2001;12:632–639.

37. **Hämmerle CH, Jung RE, Feloutzis A**. A systematic review of the survival of implants in bone sites augmented with barrier membranes (guided bone regeneration) in partially edentulous patients. J Clin Periodontol 2002;29(3):226-31

38. **Hermann JS & Buser D**, Guided bone regeneration for dental implants. Current Opinion in Periodontology 1996;3:168-177.

39. **Hislop WS, Finlay PM, Moos KF.** A preliminary study into the uses of anorganic bone in oral and maxillofacial surgery. Br J Oral Maxillofac Surg 1993;31:149-153.

40. **Hurley LA, Stinchfield FE, Bassett AL, et al**. The role of soft tissues in osteogenesis. An experimental study of canine spine fusions. J Bone Joint Surg Am 1959.

41. **Jemt T, Lekholm, Adell R.** Osseointegration in the treatment of partially edentulous patients: a preliminary study of 876 consecutively installed fixtures. Int J Oral Maxillofac Implants 1989;4:211-217.
42. **Jensen J. Sindet-Pedersen S.** Autogenous mandibular bone grafts and osseointegrated implants for reconstruction of the severely atrophied maxilla: A preliminary report. J Oral Maxillofac Surg 1991;49:1277-1287.
43. **Jia-**Hui Fu, Hom-Lay Wang. Horizontal bone augmentation. The decision tree. Int J. Periodontics Restorative Dent. 2011;31:429-436.
44. **Jovanovic SA, Schenk RK, Orsini M, Kenney EB,** Supra crestal bone formation around dental implants; An experimental dog study. Int J. Oral Maxillofac Implants 1995;10: 23-31.
45. **Khoury F, Happe A**. The palatal subepithelial connective tissue flap method for soft tissue management to cover maxillary defects: a clinical report. International J Oral Maxillofacial Implants. 2000;15(3):415-8.
46. **Lai YL, Chou IC, Liaw YC, Chen HL, Lin YC, Lee SY**. Triple immediate therapy ridge expansion, soft tissue augmentation, and provisional restoration of maxillary anterior single implant. J Periodontology. 2007 ;78:7:348-53.
47. **Lane JM.** Bone graft substitutes. West J Med 1995;163:565-566.

48. **Lazzara RJ**. Immediate implant placement into extraction sites: Surgical and restorative advantages. Int J Periodontics Restorative Dent 1989;9:333-343.

49. **Lemperle SM, Calhoun CJ, Curran RW, Holmes RE.** Bony healing of large cranial and mandibular defects protected from soft-tissue interposition: A comparative study of spontaneous bone regeneration, osteoconduction, and cancellous autografting in dogs. Plast Reconstr Surg 1998;101:660-672.

50. **Linkow LI.** Bone transplants using the symphysis the iliac crest and synthetic bone material. J. Oral Implantol 1983;11; 211-247.

51. **Luca Cordaro David Sarzi Amade Massimo Cordaro.** Clinical results of alveolar ridge augmentation with mandibular block bone grafts in partially edentulous patients prior to implant placement Clin. Oral Impl. Res. 2002;13:103–111.

52. **Lundgren AK, Sennerby L, Lundgren D, Taylor A, Gottlow J, Nyman S;** Bone augmentation at titanium implants using autogenous bone grafts and bioabsorbable barrier. Clinical Oral Implants Research 1997;8:82-89.

53. **Lundgren S, Nyström E, Nilson H, Gunne J, Lindhagen O**. Bone grafting to the maxillary sinuses, nasal floor and anterior maxilla in the atrophic edentulous maxilla. Int J Oral Maxillofac. Surg 1997;26:428-434.

54. **Maiorana C, Beretta M, Sakina S, Santoro F.** Reduction of autogenous bone graft resorption by means of Bio-Oss coverage: A Prospective study Int J Periodontics Restorative Dent 2005;25:19-25
55. **Marizo Akemi Matsumoto, Hugo Nary Fiho, Carlos Eduardo Francischone et al.** Microscopic analysis of reconstructed maxillary alveolar ridges using autogenous bone grafts from the chin and the iliac crest. Int J Oral Maxillofac Implants 2002;17:507-516.
56. **Matthews DP**, The pediculated connective tissue graft: a novel approach for the "blown-out"site in the esthetic zone. Compendium Continuing Education Dent. 2008;29:350-2.
57. **Michael W, Vannier, Charles F, Hildebolt, Gary Conover, Robert H.** Knapp. Three dimensional dental imaging by spiral ct. Oral Surgery, Oral Medicine, Oral Pathology, and Endodontology. 1997;5;561-570.
58. **Misch CE, Judy KEM:** Classification of partially edentulous arches for implant dentistry, Int J Oral Implantol 1987;4:7-12.
59. **Misch CM.** Comparison of intraoral donor sites for onlay grafting prior to implant placement. Int J Oral Maxillofac Implants 1999;12:767-776.
60. **Monica Fernandes Gomes, Mario James de Silve dos Anjos.** Autogenous Demineralized Dentin Matrix for Tissue Engineering Applications: Radiographic and Histomorphometric Studies. Int J Oral Maxillofac Implants 2002;17:488-497.

61. **Murray, Holden, Roschlau**. Experimental and clinical study of new growth of bone in a cavity. The American Journal of Surgery 1957;93(3):385-387.

62. **Nevins M, Mellonig JT, Clem DS, Reiser GN, Buser DA.** Implants in regenerated bone. Long-term survival. Int J Periodontics Restorative Dent 1998;18:35-45.

63. **Nkenke E, Schultze-Mosgau S, Radespiel-Troger M, Kloss F, Neukam FW.** Morbidity of harvesting of chin grafts: a prospective study. Clin oral implants Res 2001;12:495-502**.**

64. **Ofer Moses, Carlos E. Nemcovsky, Yair Langer, Haim Tal** : Severely Resorbed Mandible Treated with Iliac Crest Autogenous Bone Graft and Dental Implants: 17-Year Follow-up Int J Oral Maxillofac Implants 2007;22:1017–1021.

65. **Parodi R, Carusi G, Santarelli G, Nanni F**. Implant placement in large edentulous ridges expanded by GBR using a bioresorbable collagen membrane. Int J Periodontics Restorative Dent. 1998;18(3):266-75.

66. **Periklis Proussaefs, Jaime Lozada, Alejandro Kleinman, Michael D. Rohrer.** The use of ramus autogenous block grafts for vertical alveolar ridge augmentation and implant placement: A Pilot Study. Int J Oral Maxillofac Implants 2002;17:238-248.

67. **Phillips, J.H. & Rhan, B.A.** Fixation effects on membranous and endochondral onlay bone graft revascularization and bone deposition. Plastic and Reconstructive Surgery 1990;85;891–897.

68. **Pikos MA.** Alveolar ridge augmentation using mandibular block graft: Clinical Update. Alpha Omegan 2000;93(3):14-21.

69. **Pikos MA.** Block autografts for localized ridge augmentation: Part I. The posterior maxilla. Implant Dent 1999;8;279-285.

70. **Pikos MA.** Mandibular block autograft for alveolar ridge augmentation:Atlas Oral Maxillofac Surg Clin N Am 2005;13:91-107.

71. **Pommer B, Tepper G, Gahleitner A, Zechner W, Watzek G**. New safety margins for chin bone harvesting based on the course of the mandibular incisive canal in CT. Clin Oral Impl Res 2008;19(12):1312-1316.

72. **Proussaefs P, Lozada JL.** The use of intra orally harvested autogenous block graft for vertical alveolar ridge augmentation. Int J Periodontics Restorative Dent 2005;25:351-363.

73. **Proussaefs P. Lozada J.** The use of resorbable collagen membrane in conjunction with autogenous bone graft and inorganic bovine mineral for buccal/labial alveolar ridge augmentation: a pilot study. J Prosthet Dent 2003;90(6):530-538.

74. **Quirynen M, Gijbels F, Jacobs R.** An infected jawbone site compromising successful osseointegration. Periodontol 2003;33:129-144.

75. **Rissolo AR, Bennett J.** Bone grafting and its essential role in implant dentistry. Dent Clin North Am 1998;42:91-116.

76. **Rummelhart JM, Mellonig JT, Gray JL, Towle HJ.** A comparison of freeze-dried bone allograft and demineralized freeze-dried bone allograft in human periodontal osseous defects. J Periodontol 1989;60:655-663.

77. **Scharf DR, Tarnow DP**, Modified roll technique for localised alveolar ridge augmentation, Int J Periodontics Restorative Dent. 1992;12(5):415-425.

78. **Schropp L, Wenzel A, Kostopoulos L, Karring T.** bone healing and soft tissue contour changes following single tooth extraction: A clinical and radiographic 12 month prospective study. Int J Periodontics Restorative Dent. 2003;23:313-323.

79. **Schwartz Arad D, Dori S.** Intraoral autogenous onlay block bone grafting for implant dentistry (in Hebrew). Refuat Hapeh Vehashinayim 2009;19:35-39.

80. **Seibert JS.** Reconstruction of deformed partially edentulous ridges using full thickness onlay grafts. Part I. Technique and wound healing. Compend Contin Educ Dent 1983;4:437-453.

81. **Sharon R. Bannister and Charles A. Powell**. Foreign body reaction to anorganic bovine bone and autogenous bone with platelet-rich plasma in guided bone regeneration J Periodontology 2008;79:1116-1120

82. **Takeya Uchida, Takuji Yoshida, Kouki Kashiwagi, Seisyoku Lee**. Clinical, Radiographic and histologic evaluation of localized ridge augmentation using a mandibular bone block. Int J Periodontics Restorative Dent 2008;28:181-187

83. **Ten Bruggenkate CM, Krooijenhagen HA. van der Kwost WA. Krekeler G. Oosterbeek HS.** Autogenous maxillary bone grafts in conjunction with placement of ITI endosseous implants. A preliminary report. int J Oral Maxillofac Surg 1992:21:81-84.

84. Tezulas E, **Dilek OC**, **Topcuoglu N**, **Kulekci G**. Decontamination of autogenous bone grafts collected during dental implant site preparation: a pilot study Oral Surg Oral Med Oral Pathol Radiol Oral Endod 2009;107(5):656-660.

85. **Thomas Bernhart, Robert Weber, Georg Mailath, Christian Ulm.** Use of crestal bone for augmentation of extremely knife-edged alveolar ridges prior to implant placement: Report of 3 cases. Int Journal of Maxillofac Implants 1999;14: 424-427.

86. **Thomas Bernhart, Robert Weber, Georg Mailath, Christian Ulm.** Use of crestal bone for augmentation of extremely knife-edged

alveolar ridges prior to implant placement: Report of 3 cases. Int Journal of Maxillofac Implants 1999:14:424-427.

87. **Tolman DE.** Reconstructive procedures with endosseous implants in grafted bone: A review of the literature. Int J Oral Maxillofac Implants 1999;10:275-294.

88. **Tuhler RS, Orenstein IH, Morris HF, Ochi S.** Distribution of bone quality in patients receiving endosseous implants. J Oral Maxillofac Surg. 1997;55:38-45.

89. **Uchida T, Yoshida T, Kashiwagi K, Lee S, Kobayashi W, Takahashi K.** Clinical, radiographic and histologic evaluation of localizes ridge augmentation using a mandibular bone block. Int J Periodontics Restorative Dent 2008; 28:181-187.

90. **Urbani G, Lombardo G, Santi E, Tarnow D.** Localized ridge augmentation with chin grafts and resorbable pins: case reports. Int J Periodontics Restorative Dent 1998;18(4):363-375.

91. **Von Arx T, Wallkamm B, Hardt N.** Localised ridge augmentation using a micro titanium mesh; A report on 27 implants followed from 1-3 years after functional loading. Clin Oral Implants Res 1998;9;123-130.

92. **Weibull L, Widmark G, Ivanoff CJ, Borg E, Rasmusson L.** Morbidity after chin bone harvesting – A retrospective long-term follow-up study. Clin Implant Dent Relat Res 2000;11:149-157.

93. **Widmark G Andersson B Ivanoff CJ:** Mandibular bone graft in the anterior maxilla for single tooth implants: presentation of a surgical method. J Oral maxillofac surg 1997;26:106.

94. **Zins JE, Whitaker LA.** Membranous versus endochondral bone: Implications for craniofacial reconstruction. Plast Reconstr Surg 1983;72:778-785.