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Role of Osseodensification in Surgical Outcome in Dental Implant Placement: A Randomized Clinical Study

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Abstract
During implant osteotomy preparation, the maintenance and preservation of bone leads to enhanced primary mechanical stability and Bone to Implant Contact (BIC), thereby enhancing the secondary stability of implant. The standard implant site preparation techniques are subtractive in nature that use successively increasing-diameter drills rotating in a clockwise direction under copious irrigation to excavate bone and prepare the implant bed, but recently a new non-subtractive drilling technique, Osseodensification (OD), was introduced where a specially designed drills rotate in an counter clockwise direction compacting bone at the osteotomy walls allowing more intimate engagement of the implant with the osteotomy site and increasing the primary stability. It is essential to have sufficient bone bulk and density at the implant site in order to achieve good bone-to-implant contact and primary stability, which are crucial for osseointegration. The main concept of OD technique is that the drill designing creates an environment which enhances the initial primary stability through densification of the osteotomy site walls by means of auto grafting of bone.

INTRODUCTION

Modern dentistry focuses on restoring optimal form, function and aesthetics in patients, with tooth loss significantly impacting speech, chewing and bone health. Traditional prosthetics like dentures have limitations, affecting efficiency, aesthetics stability while compromising healthy adjacent teeth[1]. Dental implants, boasting over 95% success rates in long-term studies, offer a promising alternative by promoting osseointegration-the critical bond between implant and bone[2,3]. Osseointegration's success hinges on various factors such as surgical techniques, implant design loading conditions[4,5].

Osseointegration, pivotal for implant stability, occurs in primary (mechanical attachment to cortical bone) and secondary stages[6,7] (biological stability via bone regeneration). Achieving osseointegration relies on implant stability, affected by factors like bone quality, surgical technique implant design. Traditional implant preparation involves subtractive drilling methods, whereas osseodensification, a non-excavating technique introduced by Salah Huwais in 20148, uses specialized densifying burs to enhance primary stability without removing bone. This method creates a condensed autograft layer around the implant site, improving bone density and stability. Osseodensification's concept focuses on creating an environment that fosters initial stability through bone wall densification, promoting better osseointegration due to closer bone-implant interaction[8,9].

Aim and Objectives: To evaluate different implant site preparations for dental implant placement using osseodensification drilling technique compared to standard drilling technique.

To assess and compare the implant site preparation techniques, the objectives are.

- Primary stability of dental implants, by measuring insertion torque and seating torque with help of hand-held ratchet wrench
- Peri-implant bone density using CBCT values
- Ridge expansion using CBCT values

Criteria for the Selection:

Inclusion Criteria:

- Healthy individuals (ASA-I, II)
- Patients between 18-65 years
- Patients with multiple missing teeth in the maxillary and/or mandibular arch
- Patients who demonstrate good plaque control (PI<10%) and showing good compliance
- Absence of soft tissue and oral dental pathology
- Patients willing to give informed written consent to participate in the study

Exclusion Criteria:

- Patients with bleeding disorder or on anticoagulant therapy
- Pregnant and lactating females
- Patients with history of smoking, drug and alcohol abuse
- Patients treated with any medication known to cause compromised bone healing
- Patients with imm-unocompromised state and debilitating disease.
- Patients with malignancy or radiotherapy/chemotherapy for malignancy
- Patients with systemic diseases that would negatively influence wound healing
- Patients with parafunctional habits such as bruxism and clenching
- Patients having psychological problems
- Patients having inadequate mouth opening and insufficient vertical inter arch spa

Materials:

- Surgical gloves
- Disposable mouth masks
- Disposable head cap
- Normal saline
- Spirit
- 5% povidone iodine
- Sterile green clothes and towels
- Local anesthesia 2% lignocaine hydrochloride with adrenaline 1: 80,000
- Sterile gauze
- 3-0 silk suture material

Armamentarium:

- Mouth mirror
- Probe
- Tweezer
- Sponge holder
- Towel clip
- 26-gauge 1.5” needle with 2cc syringe
- 24-gauge needle with 2cc syringe
- Suction catheter
- Suction tip
- Mouth prop
- Sterile bowl
- No. 3 bard parker handle
- No. 15 bard parker blade
- Molts no. 9 periosteal elevator
- Langenback’s retractor
- Lucas curette
- Miller’s bone file
- Implant (required length and diameter as per selected site)
- Physiodispenser

- Implant handpiece
- Implant kit
- Osseodensification kit
- Hand-held ratchet wrench
- Implant cover screw
- Ellis tissue holding forceps
- Halstead's curved mosquito forceps
- Adson's forceps
- Iris tissue cutting scissor
- 3/8 reverse cutting needle
- Needle holder
- Suture cutting scisso

MATERIALS AND MATHODS

It involved a randomized clinical study on patients undergoing surgical implant placement. Detailed medical and dental assessments, along with radiographic analyses (CBCT), were conducted after obtaining informed consent. Patients were divided randomly into two groups: the Control Group, where standard drilling techniques were used for implant site preparation the Study Group, where the osseodensification drilling technique was applied.

Surgical Procedures: Performed under local anesthesia, included mucoperiosteal flap reflection, osteotomy using specific drills implant insertion. In the Control Group, sequential drilling with conventional protocols was applied, while the Study Group utilized osseodensification drilling with specific drill directions. Post-surgery, patients were provided standard care, medications post-operative instructions. Follow-ups involved radiographic analysis and clinical assessments for implant stability, bone density ridge expansion on the 7th post-operative day.

The Post-Operative Care Regimen: included pressure gauze packs, ice packs to reduce swelling, oral hygiene instructions, dietary recommendations adherence to prescribed medications. Implant stability was measured through insertion and seating torque, while radiographic analysis assessed peri-implant bone density and ridge expansion on the 7th post-operative day.

RESULTS AND DISCUSSIONS

The study was conducted at the Oral and Maxillofacial Surgery Department of Ahmedabad Dental College and Hospital, involving 50 patients with 50 implant sites. Patients were randomly divided into two groups: the Control Group, receiving standard drilling techniques the Study Group, treated with osseodensification drilling. The quantitative outcomes were analyzed using unpaired t-tests and paired t-tests, with significance at $p<0.05$.

Regarding sex distribution, both groups showed similar percentages of male and female patients

Fig. 1: Pre-operative intraoral clinical photograph

Fig. 2: Clinical photograph showing sequential drilling with osseodensification bur

Fig. 3: Clinical photograph showing Application of torque using hand- held ratchet wrench

Fig. 4: Clinical photograph showing implant placement

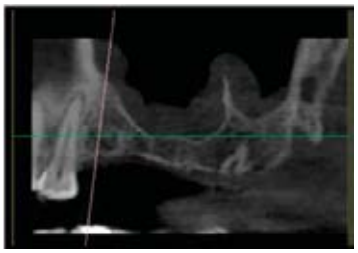

Figure 5: Pre-operative radiograph (CBCT)

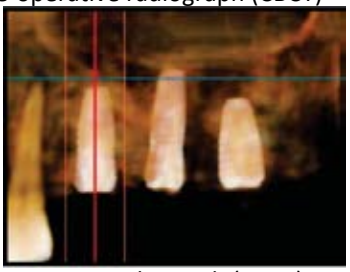

Fig. 6: Post-operative radiograph (CBCT)

Fig. 7: Pre-operative intraoral clinical photograph

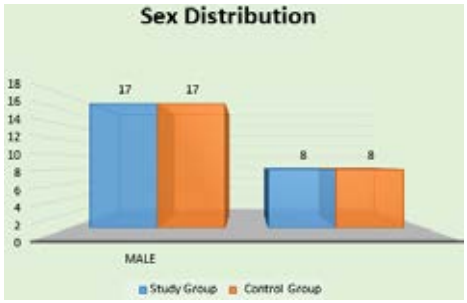

Chart: 1 Sex Distribution

Fig. 8: Clinical photograph showing sequential drilling with osseodensification bur

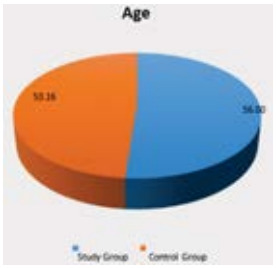

Chart: 2 Age distribution

Fig. 9: Clinical photograph showing application of torque using hand- held ratchet wrench

Chart:3 Comparison of insertion torque

Fig. 10: Clinical photograph showing implant placement

Chart: 4 Comparison of seating torque

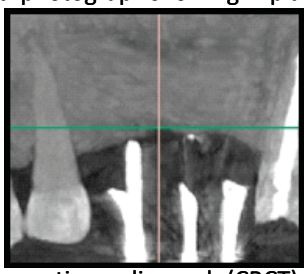

Fig. 11: Pre-operative radiograph (CBCT)

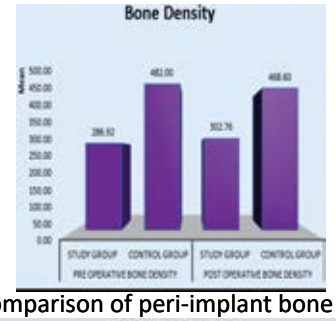

Chart: 5 Comparison of peri-implant bone density

Fig. 12: Post-operative radiograph (CBCT)

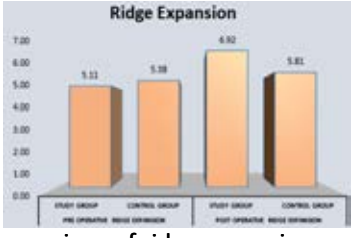

Chart: 6 Comparison of ridge expansion

(Control Group: 68% male, 32% female, Study Group: 68% male, 32% female).(Chart1) The mean age was slightly higher in the Study Group (56.00, SD 11.85) compared to the Control Group (53.16, SD 8.94). (Chart2)

Intra-operative clinical evaluations measured implant stability via insertion torque and seating torque. The Study Group showed lower mean insertion torque (33.80, SD 3.89) compared to the Control Group (36.20, SD 4.40), with a significant p-value of 0.047.(Chart 3) Seating torque was significantly higher in the Study Group (46.20, SD 4.15) than in the Control Group (39.40, SD 3.33), with a highly significant p<0.001. (Chart 4)

Pre-operative radiographic evaluations assessed peri-implant bone density and ridge width. The Control Group displayed higher mean peri-implant bone density (482.00, SD 91.69) compared to the Study Group (286.92, SD 111.59)(Chart 5), whereas ridge width was slightly smaller in the Study Group (5.11, SD 2.75) compared to the Control Group (5.38, SD 0.95).(Chart 6)

Post-operative radiographic assessments on the 7th day focused on peri-implant bone density and ridge expansion. Post-operatively, the Control Group displayed a mean bone density of 468.60 (SD 88.62) compared to 302.76 (SD 111.45) in the Study Group, with a highly significant p<0.001. Additionally, ridge expansion was higher in the Study Group (6.92, SD 2.54) than in the Control Group (5.81, SD 1.02), with a significant p<0.05.

Comparison between pre and post-operative differences in bone density and ridge expansion for both groups revealed statistically significant differences, favoring the Study Group (p<0.001 for both comparisons).

Dental implants have notably transformed oral rehabilitation with a success rate of over 90% over a decade. Albrektsson *et al*[10]. established criteria for implant success, emphasizing factors like primary stability as crucial for successful osseointegration, impacting implant, host, surgical, biomechanical systemic elements[10,11,12].

Traditional drilling techniques for implant site preparation often entail bone tissue cutting and removal, potentially sacrificing bone volume. Osseodensification (OD), a novel technique developed in 2014 by Salah Huwais, introduces specially designed Densah burs to increase bone density without removing tissue, improving primary stability by creating a condensed autograft layer around the implant[8,9].

OD's controlled bone plastic deformation differs from traditional osteotomes, generating residual strains in the bone surface that enhance bone-to-implant contact and primary stability, fostering osteogenic activity[8,13,14]. OD preserves bone, enhances density[15,16,17] expands ridges[13,14,18] increases implant stability compared to standard techniques, as demonstrated by increased torques and peri-implant bone density in studies[11,16,13]. However, it may have limitations with cortical bone or xenografts. Nonetheless, OD proves promising for preserving bone, enhancing stability paving the way for more successful dental implant procedures[9,15,20].

CONCLUSION

The study compared implant site preparations using osseodensification drilling against standard drilling techniques. Fifty implant sites were assessed based on insertion torque, seating torque, peri-implant bone density ridge expansion on the 7th post-operative day. Osseodensification demonstrated benefits in creating stronger expanded osteotomies, boosting bone density achieving higher insertion and seating torques than standard drilling. These findings suggest increased primary biomechanical stability and improved peri-implant conditions with osseodensification. However, limitations like a small sample size and potential complications were noted, urging larger-scale, long-term studies for robust evidence in this field.

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