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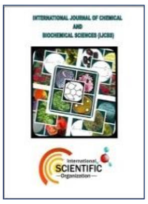

Evaluation of implant stability and bone density following Densah Burs versus Bone Expanders in Soft Bone: A Randomized Clinical Trial: A Mini Review

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Abstract

This study aimed to assess implant primary stability and radiographic bone density, comparing osseodensification burs with screw expanders in the maxilla. Twenty implants were placed in ten patients between the second right and left maxillary premolars. Each patient received one implant using an osseodensification bur and another using a screw expander. Implant stability (ISQ) was recorded intraoperatively and at 3 and 6 months. Digital radiographs were taken at these intervals and analyzed using ImageJ software for fractal analysis. Statistical analysis was applied to the collected data. No statistically significant difference was found between groups regarding bone density or stability, but both groups showed improvement over time. The osseodensification group showed higher bone density at all intervals, while the expander group recorded higher ISQ values. A negative correlation was noted between bone density and implant stability.

Keywords: Atrophic maxilla; ossedensification; Expansion; Implant stability; Bone density; Fractal analysis

Mini review article **Corresponding Author*, e-mail: *anasabobelal@gmail.com* Doi # https://doi.org/10.62877/19-IJCBS-25-27-21-19

1. Introduction

The most rapid reduction in the residual ridge occurs during the first six months post-extraction, though bone loss continues gradually over time, diminishing both the horizontal and vertical dimensions of the jaw [1] studies report that tooth loss may result in a 40% to 60% reduction in bone volume—both vertically and horizontally—in as little as three months due to ridge remodeling (Barone A et al., 2014) . Healing of the extraction socket involves internal changes that promote new bone formation while external changes lead to a reduction in ridge width and height [2]. To improve implant success, several classification systems have been proposed to assess jawbone quality preoperatively. For instance, Lekholm and Zarb1985 [3] classified bone into four types based on the panoramic radiographs and drilling resistance:

Type 1: Homogeneous, large cortical bone.
Type 2: Thick cortical bone encasing a dense medullary core.
Type 3: Thin cortical layer surrounding dense medullary bone.
Type 4: Thin cortical layer with sparse medullary bone.

Misch [4] further refined these classifications into four categories:

D1: Dense cortical bone with minimal spongy bone, providing high strength but generating more heat during drilling and reducing blood supply.
D2: Dense, porous cortical bone with coarse trabeculae, offering good bone-to-implant contact and nourishment during healing.
D3: Thinner, porous cortical bone with fine trabeculae, resulting in lower strength compared to D2.

D4: Low-density bone with little or no cortical structure, associated with a reduced implant success rate due to poor implant contact [4].

Primary implant stability—achieved by mechanically interlocking the implant surface with the osteotomy walls—is critical for successful osseointegration. Factors such as implant design, surgical technique, and bone density all play pivotal roles in establishing this stability [5]. In areas of low bone density, enhancing primary stability remains challenging. Traditional methods include under-preparation of the implant site [6], while alternative techniques, such as using osteotomes, compress the bone both apically and laterally to create a compact bone layer at the implant interface [7]. Dental implant placement has evolved into a predictable and routine treatment for restoring missing teeth and supporting dentures over past 30 years. Implant success can be influenced by various factors such as local and systemic diseases, smoking habits, medications that affect bone metabolism, and radiation therapy. The importance of local bone quantity and quality during pre-surgical planning is critical, as these factors [8].

1.1. Primary Stability

Implant stability is divided into two phases: primary and secondary. Primary stability is achieved immediately upon placement through the mechanical engagement between the implant and the bone. This phase depends on the bone's quality and quantity, as well as the implant’s design, surface characteristics, drilling speed, coolant use, drill design, and osteotomy technique (with the final drill being slightly smaller than the implant to enhance stabilization [9]. Primary stability is essential for osseointegration because the implant threads interlock with the bone, minimizing micromovements during the initial healing phase [5].

1.1.1. Factors Affecting Primary Stability

The surgical protocol emphasizes the bone quality, quantity, and density around the implant, along with the unique macro- and micro-geometric features of the implant that interlock with the surrounding bone [6].

1.2. Secondary Stability

Secondary stability develops through bone remodeling and tissue regeneration after implant placement. This phase is marked by new bone formation around the implant as osseointegration progresses [9-10].

2. Methods of Assessment of Implant Stability

Implant stability can be assessed using both invasive (destructive) and non-invasive (non-destructive) methods.

2.1. Invasive/Destructive Methods

- *Histomorphometric Analysis*

This technique quantitatively measures bone-to-implant contact and the bone area within the implant threads. Due to its invasive nature, it is used primarily in experimental and non-clinical studies [11] (Sachdeva et al., 2016).

- *Tensional Test*

Initially developed by removing the implant plate from the bone, this test was modified to apply lateral forces to cylindrical implants. However, correlating the test results with absolute mechanical properties remains challenging (Chang et al., 2012; Sachdeva et al., 2016).

- *Push-out/Pull-out Test*

This method involves inserting a cylindrical implant transcortically or intramedullarily and then applying force parallel to the interface. It is applicable only to non-threaded, cylindrical implants (Sachdeva et al., 2016).

- *Removal Torque Analysis (Reverse Torque)*

This test evaluates the implant–bone interface by measuring the force required to remove the implant. It is considered unreliable because it only indicates whether osseointegration has occurred without quantifying the degree of bone healing (Sachdeva et al., 2016).

2.2. Non-Invasive/Non-Destructive Methods

- *Percussion Test*

This simple method estimates osseointegration by evaluating the sound produced when a metallic instrument percusses the implant. A clear, ringing sound suggests successful osseointegration, while a dull sound may indicate incomplete integration.

- *Resonance Frequency Analysis (RFA)*

RFA measures implant stability by connecting a transducer (smart peg) to the implant and applying vibrational pulses. The resulting Implant Stability Quotient (ISQ) score, ranging from 1 (lowest stability) to 100 (highest stability), reflects the quality of bone–implant interface. Acceptable implant stability is generally indicated by the ISQ values between 55 and 85, with higher scores typically seen in the lower jaw [12-14].

- *Periotest® M*

This electronic device utilizes an electromagnetically driven tapping rod and an embedded accelerometer to record the implant’s response to percussion, providing additional information on stability [15].

3. Bone Density

Bone density is a crucial factor for implant success, as denser bone typically offers greater load-bearing capacity. Radiopacity is used as an indirect measure of bone density by determining the mass per volume (D=M/V), which is proportional to the calcium content in the bone [16-17]. Primary and secondary stabilization of dental implants are significantly affected by the drilling technique used [18].

3.1. Methods of Assessment of Bone Density

- *Histological and Morphometrical Measurement*

Small trephine biopsies allow for a detailed histomorphometric evaluation of trabecular bone, regarded as the gold standard for jawbone density measurement [19].

- *Micro-Computed Tomography (mCT)*

mCT provides three-dimensional data on trabecular thickness and separation, though its use is limited to ex vivo studies due to the time required [19].

- *Quantitative-Computed Tomography (qCT)*

qCT measures bone mineral density using Hounsfield Units (HU). However, its application in dental implantology is limited by the small region of interest required (Barunawaty. 2011).

- *Dual Energy X-ray Absorptiometry (DXA) Scan*

DXA offers a low-cost, low-radiation method to assess bone density with high accuracy, though its lack of cross-sectional imaging limits its usefulness in precise implant planning [20].

- *Fractal Analysis*

Fractal analysis evaluates the complexity of trabecular bone patterns, with higher fractal dimensions correlating with increased bone density. This method helps diagnose conditions such as osteoporosis and periodontal disease and is useful for both pre-surgical planning and post-transplant follow-up [21-25].

4. Expansion

Successful implant placement requires not only adequate bone quality but also sufficient bone volume. At least 1 mm of buccal and lingual bone is needed around the implant to ensure long-term success [26]. When bone volume is insufficient, various surgical augmentation techniques are employed, including:

Lateral Augmentation and Guided Bone Regeneration (GBR): Although effective, GBR may be limited by complications such as membrane exposure, infection, and unpredictable bone resorption [27-28].

*Ridge Expansion and Splitting***:** These methods address horizontal atrophy by widening the alveolar ridge using autogenous bone. However, they require precise cortical and cancellous bone conditions to prevent fractures, especially in aesthetic areas [29-30].

Use of Expanders: Alveolar expanders enable rapid, non-traumatic lateral bone expansion by condensing the bone rather than removing it. Advantages include simultaneous implant placement, reduced need for bone harvesting, shorter treatment times, and improved stability. Yet, complications such as fractures of the labial or buccal bone plate may occur, particularly in the [27-31-33].

5. Osseodensification

Osseodensification enhances implant stability by preserving and compacting bone during osteotomy preparation. Unlike conventional drilling, which removes bone, Densah burs—introduced in 2013—operate in a pumping motion under copious irrigation to densify and expand the osteotomy site. This technique is particularly beneficial in low bone density areas, as it increases primary stability and promotes faster healing [34-35]. When used in soft bone, these burs densify both implant and surrounding bone without cutting at a negative angle [36]. Studies have shown that osseodensification produces higher removal torque and increased bone density at the implant surface compared to conventional drilling methods [5]. Advantages include a controlled, efficient process that minimizes bone removal and allows for insertion of wider diameter implants in narrow ridges without causing dehiscence. However, in very dense bone (D1, D2), excessive lateral compression may damage the trabecular structure, leading to micro-damage, delayed healing, or even bone necrosis [37-41].

6. Conclusions

Both expanders and osseodensification burs enable successful implant insertion in a resorbed maxilla with acceptable stability. The osseodensification bur can be used more quickly.The expander technique demonstrated higher implant stability, as measured by Osstell. Higher bone density was recorded in osseodensification group by fractal analysis.

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