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EVALUATION OF THE EFFECT OF MAGNETIC MALLET VERSUS CONVENTIONAL DRILLING IMPLANT PLACEMENT PRO-TOCOL ON PERIIMPLANT OSSEOINTEGRATION IN ANTERIOR MAXILLARY REGION

Ahmed A. Sanad [1*] BDS, Samraa A. Elsheikh[2] PhD,
Gaafar N. El Halawani[3] PhD

ABSTRACT

BACKGROUND: Implant osteotomy preparation traditionally involves drilling burs, which can cause mechanical trauma and bone necrosis. Magnetic Mallet osteotomy is an alternative minimally invasive technique that aims to be promote healing. New instruments using magneto-dynamic technology are being proposed for bone surgery, including dental implant site preparation.

THIS STUDY AIMS: To evaluate clinically and radiographically the effect of Magnetic Mallet osteotomies versus conventional drill implant osteotomies on implant stability, bone density and marginal bone loss in anterior maxilla.

MATERIALS AND METHODS: A randomized, controlled, parallel-arm clinical trial was conducted on patients requiring dental implants to restore their unitary edentulous in the anterior maxilla. Patients who met the inclusion criteria were randomly divided into two groups: study group (osteotomies with Magnetic Mallet) and control group (osteotomies with conventional drill system). The patients were clinically evaluated for primary stability and radiographically evaluated by CBCT immediate postoperatively and after 6 months to assess bone density and peri-implant bone height.

RESULTS: The percentage change in bone density between immediate postoperative and after six months was significantly higher in the Magnetic Mallet group compared to the conventional drilling group. The stability ISQ comparison between immediately postoperative and four months postoperative revealed a significant increase in both groups, The average crestal bone loss six months postoperatively with no statistically significant difference between the two studied groups.

CONCLUSION: Compared to the traditional drill system, the Magnetic Mallet demonstrated superior osteointegration, a gradual reduction in pain, and a notable increase in postoperative implant stability.

KEYWORDS: Implant, Low speed drilling, Magnetic Mallet, Primary stability, Heat generation.

RUNNING TITLE: Evaluation of magnetic mallet versus conventional drill system.

1-BDS, 2012, Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Alexandria University, Alexandria, Egypt
2-Professor of Oral and Maxillofacial Surgery, Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Alexandria University, Alexandria, Egypt
3 -Assistant Professor of Oral and Maxillofacial Surgery, Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Alexandria University, Alexandria, Egypt

Corresponding author:
dr.ahmed.abdulazim.sanad@gmail.com

INTRODUCTION

Extensive research has been conducted on the factors associated with dental implant prognosis and implant failure (1). It is well known that crestal bone loss below 1.5 mm in the initial year, and subsequent annual bone level alterations of 0.2 mm at the interface between implants and bones fall within the scope of normal physiologic processes. While the reduction in crestal bone height around the implant in the initial stages of healing is deemed an acceptable physiological occurrence, persistent loss of crestal bone height after osseointegration may lead to heightened mobility and eventual failure (2).

Several dependents are thought to affect the preservation of crestal bone height post-implants placement. These dependents include implants placement technique, the duration of loading, the necessity for bone grafting at the implant site, the existence of infections or medical conditions that affect wound healing, smoking, oral hygiene status, the specific location of implant placement, and the implant size. Additionally, mechanical dependents including elevating elevation during surgery, instrument overheating leading to Osteonecrosis, occlusal trauma, cantilever effect, and physiologic bone remodeling due to inflammatory processes and plaque accumulation have also been proposed (2).

The induction of heat during drilling, leading to bone tissue necrosis, could be a significant factor contributing to early implant failure. Because bone tissues are sensitive to heat, elevated heat levels during surgical procedures may have the potential to harm bones. The frictional heat generated during bones osteotomy is

influenced by factors such as the size, shape, and material of the drill, usage of irrigation, and the density of the bone (3).

Traditionally, the preparation of implant sites has involved the use of drills with various shapes conforming with the geometry of the implant. The drilling process poses a risk for failure, as it can result in both mechanical trauma to the bone and heat-induced bone necrosis. Conventional rotary instruments, typically used in osteotomies, produce excessive heat, which has the potential to impact the viability of bone cells, leading to thermal necrosis (4).

The objective of bone surgery techniques is to minimize invasiveness and promote the healing process. Consequently, innovative instruments have been developed for the preparation of implant bone sites, offering an alternative to traditional drills. These instruments aim to reduce surgical trauma, enhance precision in cutting, improve primary stability, and decrease both healing times and associated morbidity. A novel instrumentation utilizing magneto-dynamic technology has been suggested for various bone surgeries, including the preparation of dental implant sites (5).

A protocol for Magnetic Mallet osteotomy, utilizing magneto-dynamic technology, has been introduced for the preparation of implant bone sites. This serves as an alternative to traditional drills with the goal of minimizing invasiveness, reducing surgical trauma, achieving enhanced control over the cutting process, improving primary stability, and reducing both healing times and associated morbidity (6).

The existing literature on this method is notably scarce, consisting solely of observational clinical studies that compare Osseo-condensation with the conventional drill technique for implant site preparation, this study aimed to compare the technique of osteotomy with traditional drill system with osteotomy with Magnetic Mallet. The objective was to evaluate primary stability, lateral bone condensation, heat generation and postoperative inflammation (6).

The null hypothesis of the study was that there would be no clinical and radiographic significant differences between the magneto-dynamic technology and the conventional drilling techniques regarding the effect on peri-implant osteointegration. The alternative hypothesis suggested that the magneto-dynamic technology would exhibit significantly better clinical and radiographic results compared to the conventional drilling technique.

The aim of study was to clinically and radiographically evaluate the effect of Magnetic Mallet osteotomies compared to conventional implant osteotomies on peri-implant bone density, crestal bone loss and implant stability.

MATERIALS AND METHODS

Research design

Study design

This study was a randomized controlled clinical trial that was conducted and reported according to the CONSORT guidelines (7). The PICO question stated: In patients presenting with anterior maxillary missing teeth needing implant, does treatment with Magnetic Mallet osteotomy protocol compared to conventional implant osteotomy protocol show better osseointgration and implant stability?

Study setting and location

Patients were recruited to outpatient clinics of Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Alexandria University. Surgical procedures were operated in the minor surgery clinics of the same department.

Sample randomization

Eligible patients were randomly allocated in two equal groups, by simple randomization using computer generated random allocation software (www.Randomizer.org.). Group A (study group) included eight patients with edentulous maxillary anterior region, and were treated using magnato-dynamic osteotomies. Group B (controlled group) included eight patients with edentulous maxillary anterior region, and were treated using conventional drilling osteotomies.

Sample size estimation

The required sample size was calculated based on a past study that aimed at assessing the relation between implant stability and bone density derived from computerized tomography analysis. Merheb J et al. (2018) (8) concluded that the primary stability of implants is notably influenced by both bone density and cortex thickness. Implants that are longer and wider tend to achieve greater primary stability compared to their shorter and narrower counterparts. However, these correlations become less significant after the completion of osseointegration. The sample size was estimated to detect the difference in bone stability between Magnetic Mallet and conventional drilling implant placement protocols. Based on Merheb J et al. (2018) (8), adopting a power of 80% to detect a standardized effect size in bone stability of 1.576, and level of significance 5%, the minimum required sample size was calculated to be 6 patients per group, increased to 8 to account for a drop-out rate of 10% (Total sample size= 8×2= 16 patients) (9). The sample size was calculated using G*Power version 3.1.9.2 (10).

Allocation concealment

Each patient was assigned a unique serial number for the purpose of allocation. A copy of this number was securely stored in an opaque envelope, that indicates the patient's group allocation. This sealed envelope was entrusted to o an impartial party unrelated to the trial, with the sole

responsibility of unfolding it during the intervention. This ensured that the allocation group for each patient remained concealed from the investigator.

Eligibility criteria: were established as follows:

Inclusion criteria: Patients with missing maxillary anterior tooth, aged between 20 - 40 years old, with good oral hygiene, adequate inter-occlusal distance, adequate keratinized mucosa and D3 or D4 bone quality (11).

Exclusion criteria: Aggressive periodontitis patients, those with parafunctional habits (Bruxism or clenching), heavy smokers, uncontrolled diabetic patients, patients receiving radiotherapy or chemotherapy and immunosuppressed patients (12).

MATERIALS

Implants (Biodem standard line form dental implant, Germany). Fig. 1 (A)

Surgical kit of implant system (Biodem surgical kit, Germany).

Magnetic Mallet (osseotouch. Italy). Fig. 1 (B)

Osteotome kit of Magnetic Mallet (osseotouch. Italy). Fig. 1 (C)

Ostell ISQ (Gothenburg, Sweden). Fig. 1 (D)

Implant motor (coxo motor, Koria).

Osteotomies Kit

The osteotomies kit offers a set of instruments of different conical geometries and progressively wider diameters. The osteotomies utilized with the Magnetic Mallet equally compress the trabecular bone laterally and apically to enhance bone density for implants osteotomy. The process is completely heat-free, therefore does not need any irrigation. Furthermore, none of the bone mass is removed, resulting in an extremely bone conservative procedure. The osteotomies kit offers 5 different sizes and curvatures for better access to the posterior regions for a total of 10 instruments. Three additional sizes are available as (special instruments) for a total of 8 straight and 8 curved osteotomies (13). Fig. 1 (C)

Preoperative phase

History of the patient was documented in full details including name, age, gender, occupation, address, and general medical condition.

Clinical examination: the site of implant placement, inter-occlusal distance, and the status of neighboring teeth were clinically evaluated. Fig. 2 (A)

Pre-operative radiographic examination: using CBCT was performed for all patients for diagnosis and treatment planning. Fig. 2 (B,C)

Pre-operative preparations: Preoperative scaling and root planning were performed, oral hygiene instructions were given, and surgical stents were fabricated for all patients.

Surgical Phase (14)

Local anesthesia: all patients were operated under local anesthesia. (2% lidocaine Xylestesin to all patients).

Implant placement: Group A (osteotomy with Magnetic Mallet osteotomy) and group B (with traditional drill system).

Surgical procedure of group A (osteotomy with Magnetic Mallet) (15)

Following the exposure of the bone crest using a full thickness flap, the implant site was initially identified using the Osteotomy 100P (sharp tip) with force set at 1 or 2 according to bone density. The implant site was then formed by the expansion of the bone tissue in both lateral directions along the existing walls and apically. The osteotomy was gradually expanded with the force imparted to the osteotomes by the Magnetic Mallet with a maximum advancement of 1.1 mm at each pulse. The sequence of the osteotomes to be employed was predetermined based on the width and height of the implant site being prepared. For this specific surgical procedure, the forces were set at 2 or 3 according to bone density. Fig. 2 (D-I), Fig. 3 (A-F)

Surgical procedure of group B (osteotomy with conventional drilling) (16)

After exposing the crestal bone with a full thickness flap, a stepwise drilling process, concluding with the final drill, was performed using conventional drills. Subsequently, the implant was inserted using a torque wrench. Fig. 3 (G-L)

Post-operative phase

Post-surgical instructions: Cold fomentations for the initial 24 hours, warm mouthwash starting from the following day, and oral hygiene instructions.

Post-operative medications: antibiotic in the form of Amoxicillin 875mg + Clavulanic acid 125mg tablets for 7 days 2 times daily (Augmentin 1 g tablet: Amoxicillin 875 mg + Clavulanic acid 125 mg: Glaxo SmithKline, UK.), non-steroidal anti-inflammatory drug Diclofenac potassium 50 mg tablets for 5 days 3 times daily (Cataflam 50 mg Novartis Switzerland), and warm mouth wash chlorohexidine HCL (0.12%) from the second day (Hexitol, Arab Drug Company, Egypt).

Prosthetic phase

The patient was referred to the prosthodontics department for the completion of the final porcelain fused to metal restoration three months after the surgery. Fig. 3 (F)

Post-operative follow up

Clinical evaluation (12)

Pain: was evaluated 24 hours, 72 hours and 7 days after surgery using the Visual Analogue Scale (VAS).

The primary stability test was evaluated immediately postoperative and after 4 months using Osstell ISQ. Fig. 2 (J)

Post-operative radiographic evaluation (17)

Bone density

CBCT was performed immediately postoperative and at 6 months to measure peri-implant bone density measure by EZDENT software (www.vatech.com). The measurement was performed by selecting a region of interest with fixed dimensions located at the mesial and distal aspects of the implant, and the mean density was calculated. Fig. 4 (A-D)

Crestal bone loss

Crestal bone loss was measured as the distance between two points: one on the platform of the implant and other on the first point of contact with the bone. This measurement was taken both mesially and distally, and the mean distance was calculated. Fig. 4 (E-F)

Statistical Analysis

The collected data underwent statistical analysis and were presented in the form of tables, graphs, and charts using IBM Statistical Package for Social Science (SPSS) software version 22.0.

Before undergoing any procedures, all patients signed an informed consent form, ensuring their understanding of the potential outcomes and risks associated with the intervention. The clinical aspect of the study was conducted after receiving the ethical clearance wfrom the Research Ethics Committee, Faculty of Dentistry, Alexandria University.

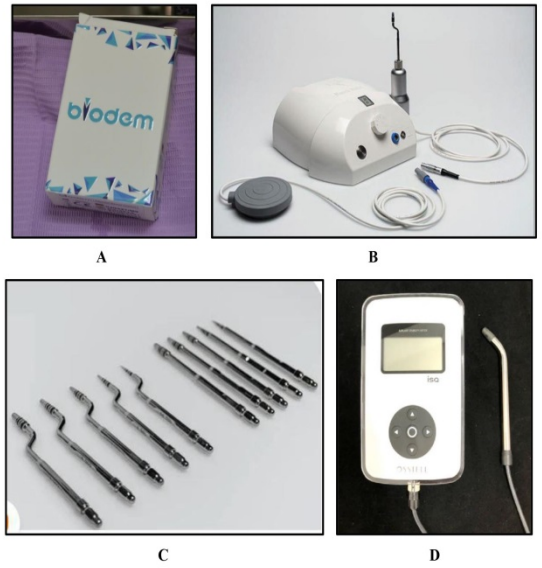

Figure (1): A) Implants (Biodem standard line form dental implant), **B)** Magnetic Mallet, **C)** Osteotome kit of Magnetic Mallet, **D)** Ostell ISQ

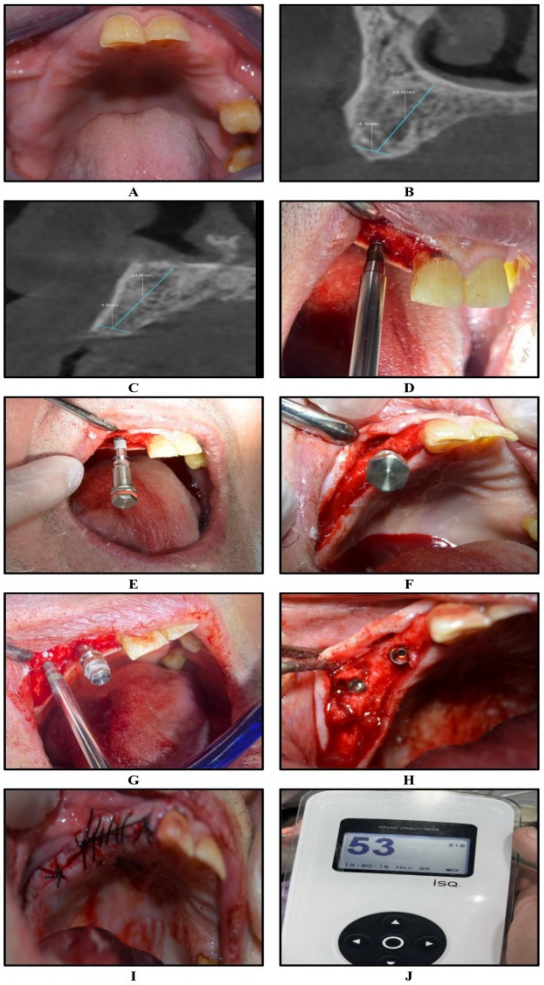

Figure (2): A) The site of implant placement, **B)** Pre-operative radiographic examination Magnetic Mallet case 1, **C)** Pre-operative radiographic examination Magnetic Mallet case 2, **D)** Osteotomy with Magnetic Mallet case 1, **E)** Implant placement case 1, **F)** Implant placement case 1, **G)** Osteotomy with Magnetic Mallet case 2, **H)** After implant placement, **I)** Suture closure, **J)** Stability measured immediately after implant placement

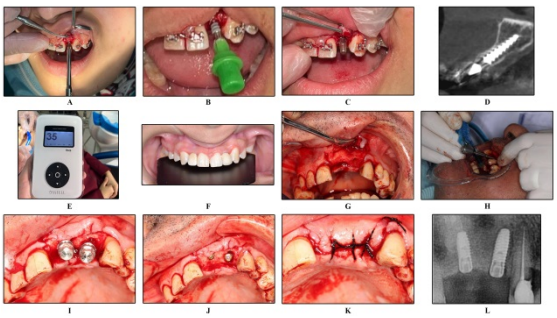

Figure (3): A) Magnetic mallet tapping, **B)** Implant placement, **C)** Implant placement, **D)** Post operative Xray, **E)** Implant stability test, **F)** Crown installation, **G)** Exposure of the bone crest using a full thickness flap, **H)** Drilling process, **I)** Implant placement, **J)** Cover screw placement, **K)** Suture closure, **L)** Post-operative X-ray

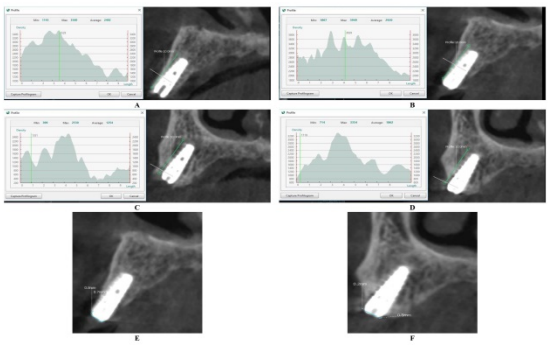

Figure (4): A) Bone density Immediately Postoperative in Magnetic Mallet group A case 1, **B)** Bone density 6 month Postoperative in Magnetic Mallet group A case 1, **C)** Bone density Immediately Postoperative in Magnetic Mallet group A case 2, **D)** Bone density 6 month Postoperative in Magnetic Mallet group A case 2, **E)** Crestal Bone Loss in Magnetic Mallet group A case 1, **F)** Crestal Bone Loss in Magnetic Mallet group A case 2

RESULTS

This study comprised 16 patients, randomly allocated to two equal groups: Group A (study group) with eight patients treated using magneto-dynamic osteotomies, and Group B (controlled group) with eight patients treated using conventional drilling osteotomies.

Age and Sex

In the Magnetic Mallet group (n=8), the age ranged from 20 to 40 years old, with a median of 37.00, a 95% Confidence Interval (CI) of the median of 31.00-52.00, and a 25th Percentile–75th Percentile of 20-40 years. For the conventional drilling group (n=8), the age ranged from 20-40 years old, with a median of 39.00, 95% CI of the median of 27.00-52.00, and 25th Percentile– 75th Percentile of 30.00-46.00 years. There was no statistically significant difference in age between the two groups *(p=.874).* Fig. 5 (A)

In the Magnetic Mallet group (n=8), males constituted 4/8 (50.00%), and females represented 4/8 (50.00%). In the Conventional drilling group (n=8), males were 5/8 (62.50%), while females were 3/8 (37.50%). There was no statistically significant difference in sex between the two groups (p=1.000).

CLINICAL follow up

Pain (VAS)

Twenty-four hours postoperatively

In the Magnetic Mallet group (n=8), the VAS ranged from 5.00 to 7.00, with a median of 6.00, a 95% CI of the median of 6.00-7.00, and 25th Percentile– 75th Percentile of 5.00-6.00. In the Conventional drilling group (n=8), the VAS ranged from 5.00 to 7.00 mm, with a median of 5.50, 95% CI of 5.00-6.00, and 25th Percentile – 75th Percentile of 5.00-6.00. There was no statistically significant difference in VAS between the two studied groups twenty-four hours postoperatively. (p=.687). Fig. 5 (B)

Seven days postoperatively

In the Magnetic Mallet group (n=8), the VAS ranged from 1.00 to 2.00, with a median of 1.00, and a 25th Percentile– 75th Percentile of 1.00-2.00. In the Conventional drilling group (n=8), the VAS ranged from 1.00 to 3.00 mm, with a median of 1.50, 95% CI of the median of 1.00-2.00, and 25th Percentile – 75th Percentile of 1.00-2.00. There was no statistically significant difference in VAS between the two studied groups seven days postoperatively. (p=.511). Fig. 5 (B)

In each group, repeated measures analysis showed a statistically significant decrease in the VAS among the different timepoints in both the Magnetic Mallet group and the Conventional drilling group (p<.001 and p<.001, respectively). Pairwise comparisons of different measurements revealed that VAS after seven days postoperatively was significantly lower compared with 24 hours postoperative in both the Magnetic Mallet, and the Conventional drilling groups (p<.001 and p<.001, respectively). Fig. 5 (B)

Percentage change (%) (7days vs. 72 hrs)

In the Magnetic Mallet group (n=8), the VAS ranged from -66.67 to -33.33 (%), with a median of -50.00(%), a 95% CI of the median of -50.00 - -33.33 (%), and 25th Percentile – 75th Percentile of -66.67 - -41.67 (%). In the Conventional drilling group (n=8), the VAS ranged from -75.00 to -25.00 (%), with a median of -41.67 (%), a 95% CI of the median of -66.67 - -33.33 (%), and 25th Percentile – 75th Percentile of -58.33 - -33.33 (%). VAS percentage change (%) (7 days vs. 72 hrs) did not differ significantly between the two studied groups. (p=.413).

Implant Stability (ISQ)

Immediate postoperative

In the Magnetic Mallet group (n=8), the ISQ ranged from 62.00 to 70.00, with a median of 64.50, a 95% CI of the median of 063.00-68.00, and a 25th Percentile– 75th Percentile of 63.00-66.50. In the conventional drilling group (n=8), the ISQ ranged from 60.00 to 72.00, with a median of 65.00 and 95% CI of the median of 64.00-72.00, and 25th Percentile– 75th Percentile of 64.00-68.00. The ISQ did not differ significantly between the two studied groups immediately postoperative. (p=.524). Fig. 6 (A) and Table (1)

Four months postoperative

In the Magnetic Mallet group (n=8), the ISQ ranged from 68.00 to 80.00, with a median of 75.50, a 95% CI of the median of 68.00-80.00, and a 25th Percentile– 75th Percentile of 70.50-79.50. In the conventional drilling group (n=8), the ISQ ranged from 67.00 to 92.00, with a median of 71.50 and 95% CI of the median of 66.00-85.00, and 25th Percentile– 75th Percentile of 69.50-80.00. The ISQ

did not differ significantly between the two studied groups four months postoperative. (p=.673). In each group, the ISQ comparison between immediately postoperative and four months postoperatively revealed a significant increase in both the Magnetic Mallet and the conventional drilling groups (p=.011, and p=.011, respectively). Fig. 6 (A) and Table (1)

Percentage change (%)

In the Magnetic Mallet group (n=8), the ISQ ranged from 4.29 to 26.98 (%), with a median of 18.41 (%), a 95% CI of the median of 4.62-25.00 (%), and 25th Percentile – 75th Percentile of 4.62-22.98 (%). In the conventional drilling group (n=8), the ISQ ranged from 4.17-41.54 (%), with a median of 7.76 (%), a 95% CI of the median of -4.48-23.19 (%), and a 25th Percentile – 75th Percentile of -4.58-22.43 (%). ISQ percentage change (%) did not differ significantly between the two studied groups. (p=.834). Fig. 6 (A) and Table (1)

RADIOGRAPHIC follow up

Bone density

Immediately Postoperative

In the Magnetic Mallet group (n=8), the bone density ranged from 928.00 to 1536.00 HU, with a median of 1116.00, a 95% CI of the median of 1006.00-1225.00, and a 25th Percentile– 75th Percentile of 1053.00-1205.50 HU. In the conventional drilling group (n=8), the bone density ranged from 985.00 to 2200.00, with a median of 1350.00 and 95% CI of the median of 1000.00-1920.00, and 25th Percentile– 75th Percentile of 1015.00-1860.00 HU. Bone density did not differ significantly between the two studied groups immediately preoperative. (p=.345). Fig. 4 (A,C) and Fig. 6 (B) and Table (2)

Six months postoperative

In the Magnetic Mallet group (n=8), the bone density ranged from 1122.00 to 1811.00 HU, with a median of 1454.00, a 95% CI of the median of 1152.00-1529.00, and a 25th Percentile– 75th Percentile of 1201.00-1525.50 HU. In the conventional drilling group (n=8), the bone density ranged from 1122.00 to 2445.00, with a median of 1500.00 and 95% CI of the median of 1180.00-2258.00, and 25th Percentile– 75th Percentile of 1215.00-2084.00 HU. Bone density did not differ significantly between the two studied groups six months preoperatively. (p=.462). In both the Magnetic Mallet and the conventional drilling groups, repeated measures analysis showed a statistically significant increase in the bone density between immediate postoperative and six months postoperatively measurements (p=.012, and p=.012, respectively). Fig. 4 (B,D) and Fig. 6 (B) and Table (2)

Percentage change (%)

In the Magnetic Mallet group (n=8), the bone density ranged from 11.50 to 32.55 (%), with a median of 24.48 (%), a 95% CI of the median of 12.41-56.25 (%), and 25th Percentile– 75th Percentile of 15.16-44.40 (%). In the conventional drilling group (n=8), the bone density ranged from 6.17 to 21.36, with a median of 13.99 (%), 95% CI of the median of 8.98-18.00 (%), and 25th Percentile– 75th Percentile of 10.06-17.80 (%). Bone density percentage change between immediate postoperative and six months postoperatively was significantly higher in the Magnetic Mallet group compared to the conventional drilling group. (p=.036).

Average Crestal Bone Loss (mm)

Six months postoperative

In the Magnetic Mallet group (n=8), the average crestal bone loss ranged from 0.15 to 1.55 mm, with a median of 0.32, a 95% CI of the median of 0.25-0.55, and a 25th Percentile– 75th Percentile of 0.25-0.55 mm. In the conventional drilling group (n=8), the average crestal bone loss ranged from 0.20 to 1.00 mm, with a median of 0.28, 95% CI of the median of 0.20-0.80, and 25th Percentile– 75th Percentile of 0.23-0.60 mm. Average crestal bone loss did not differ significantly between the two studied groups six months postoperatively. (p=.874). Fig. 4 (E,F), Fig. 6 (C) and Table (3)

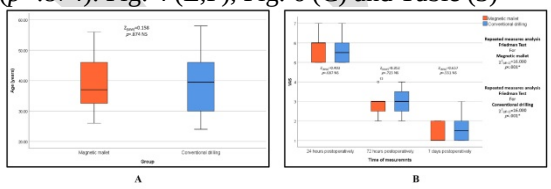

Figure (5): A) Box and whisker graph of age (years), **B)** Box and whisker graph of VAS in the two studied groups

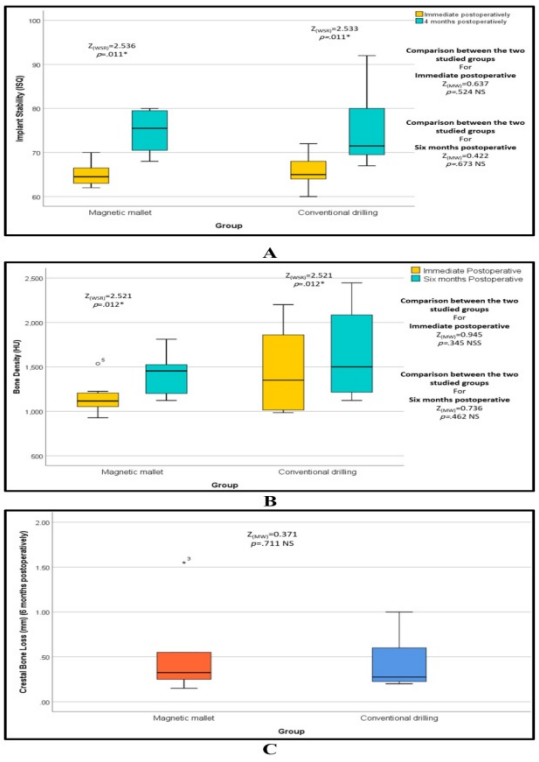

Figure (6): A) Box and whisker graph of implant stability in the studied groups (ISQ), **B)** Box and whisker graph of Bone density (HU) in the studied groups **C)** Box and whisker graph average Crestal Bone Loss (mm) (6 months postoperatively) in the studied groups

Table (1): Comparison of Implant Stability (ISQ) between the two studied groups

Implant Stability (ISQ)	Group		Test of significance *p* value
	Magnetic mallet (n=8)	Conventional drilling (n=8)	
Immediate postoperatively Min-Max Median 95% CI for mean 25th Percentile – 75th Percentile	62.00-70.00 64.50 63.00-68.00 63.00-66.50	60.00-72.00 65.00 64.00-72.00 64.00-68.00	$Z_{(MW)}$ = 0.637 *p*=.524 NS
Four months postoperatively Min-Max Median 95% CI for mean 25th Percentile – 75th Percentile	68.00-80.00 75.50 68.00-80.00 70.50-79.50	67.00-92.00 71.50 69.00-85.00 69.50-80.00	$Z_{(MW)}$ = 0.422 *p*=.673 NS
Test of significance *p* value	$Z_{(WSR)}$ =2.536 *p*=.011*	$Z_{(WSR)}$ =2.533 *p*=.011*	
Percentage change (%) Min-Max Median 95% CI for mean 25th Percentile – 75th Percentile	4.29-26.98 18.41 4.62-25.00 4.62-22.98	4.17-41.54 7.76 4.48-23.19 4.58-22.43	$Z_{(MW)}$ = 0.210 *p*=.834 NS

n: Number of patients
Min-Max: Minimum – Maximum
CI: Confidence interval
MW: Mann-Whitney U test
* : Statistically significant ($p<0.05$)
NS: Statistically not significant ($p\geq0.05$)

Table (2): Comparison of Bone density (HU) between the two studied groups

Bone density (HU)	Group		Test of significance *p* value
	Magnetic mallet (n=8)	Conventional drilling (n=8)	
Immediate postoperative Min-Max Median 95% CI for median 25th Percentile – 75th Percentile	928.00-1536.00 1116.00 1006.00-1225.00 1053.00-1205.50	985.00-2200.00 1350.00 1000.00-1920.00 1015.00-1860.00	$Z_{(MW)}$ = 0.945 *p*=.345 NS
Six months postoperative Min-Max Median 95% CI for median 25th Percentile – 75th Percentile	1122.00-1811.00 1454.00 1152.00-1529.00 1201.00-1525.50	1122.00-2445.00 1500.00 1180.00-2258.00 1215.00-2084.50	$Z_{(MW)}$ = 0.736 *p*=.462 NS
Test of significance *p* value	$Z_{(WSR)}$ = 2.521 *p*=.012*	$Z_{(WSR)}$ = 2.521 *p*=.012*	
Percentage change (%) Min-Max Median 95% CI for median 25th Percentile – 75th Percentile	11.53-32.55 24.48 12.41-29.46 15.16-28.90	6.17-21.36 13.99 8.98-18.00 10.06-17.80	$Z_{(MW)}$ = 2.100 *p*=.036*

n: Number of patients
Min-Max: Minimum – Maximum
CI: Confidence interval
MW: Mann-Whitney U test
* : Statistically significant ($p<0.05$)
NS: Statistically not significant ($p>0.05$)

Table (3): Comparison of Average Crestal bone loss (mm) between the two studied groups

Crestal Bone Loss (mm)	Group	
	Magnetic mallet (n=8)	Conventional drilling (n=8)
Six months postoperative Min-Max Median 95% CI for mean 25th Percentile – 75th Percentile	 0.15-1.55 0.32 0.25-0.55 0.25-0.55	 0.20-1.00 0.28 0.20-0.80 0.23-0.60
Test of significance *p* value	$Z_{(MW)} = 0.371$ *p*=.7874 NS	

n: Number of patients
Min-Max: Minimum – Maximum
CI: Confidence interval
MW: Mann-Whitney U test
NS: Statistically not significant (p>0.05)

DISCUSSION

In the current study, repeated analysis within both groups showed a statistically significant decrease in the pain across time (p<.001). However, the percentage change in pain scores did not differ significantly between the two studied groups. This finding agrees with Gaspar (2019) who assessed the Magnetic Mallet for bone osteotomy and showed that its usage was minimally invasive for the patient, thereby helping to avoid pain (18).

Crespi R., Bruschi G.B.in their study, reported that the Magnetic Mallet handpiece generates a longitudinal motion along the central axis of the osteotome/chisel. This motion influences and pushes the internal wall of the hole outward radially, causing a controlled fracture and displacement of cortical bones. This enhances bone tissues density along the walls. Additionally, the magnet mallet is currently considered the benchmark for inserting blade- and wedge-implant. In line with our results, Crespi et al. indicated that the mean bone loss was insignificantly lower in the test group at different follow-up periods of 6-, 12, and 24-months (6). Crespi et al. also showed stable marginal bone levels across time with a significant increase in bone height between 6 and 12 months using the Magnetic Mallet technique (6). Additionally, Gaspar (2019) reported the favorable results with the surgical technique using the Magnetic Mallet and concluded that, especially in cases of risk patients and lesser bone mass, the Magnetic Mallet helps in preparing implant sockets with minimal bone loss (18). In some cases, there is no bone loss at all, and in other cases the bone loss is minimal when compared to that caused by traditional drills. Gaspar (2019) (18) reported the favorable results after using the Magnetic Mallet for shaping the bone in a sample of 269 subjects. He emphasized that during the preparation of implant sockets, the bone is gently parted rather than drilled. This approach allows for the preservation of the bone without the need for shaving, minimizing any loss.

CONCLUSIONS

The Magnetic Mallet demonstrated superior peri-implant bone formation, osseointegration, and immediate postoperative implant stability compared to conventional drilling.

The Magnetic Mallet is recommended for achieving better bone density and postoperative implant stability than the conventional drill system. Additionally, the magnetic mallet is recommended for causing less postoperative pain than the conventional drill system. We recommend testing our hypothesis and study design on a larger sample size in different areas and with a longer follow-up period to comprehensively assess the success rate of both methods. Future studies will be recommended to evaluate long-term data on the application of the Magnetic Mallet to different implants.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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