# Evaluation of Oversized Drilling on Implant Survival and Stability Versus Traditional Drilling Technique: A Randomized Clinical Trial

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***Purpose:*** This study aimed to investigate the influence of oversized drilling on the stability of the implant and the bone response during osseointegration. ***Materials and Methods:*** The trial was designed as a prospective, parallel-group randomized controlled clinical trial with 20 implants placed in the posterior region of the maxilla. The sample size was divided into two groups, 10 each, with implants being placed with manufacturer-recommended implant osteotomy preparation according to the manufacturer guidelines in one group (MR group) vs oversized osteotomy preparation (3 to 5 mm) in the other group (oversized drilling [OD] group). The implant stability was monitored for 3 months by means of resonance frequency analysis, while the crestal bone levels were recorded using parallel technique periapical radiography for 6 months. Patient-reported outcomes including pain, swelling, satisfaction, and implant survival were all monitored throughout the study. ***Results:*** In the MR group, a mean decrease in implant stability quotient (ISQ) values was detected during the first 4 weeks, after which a gradual increase in values was recorded. In comparison, the OD group showed a rapid increase in ISQ value over the entire follow-up period from baseline and up to week 12. Regarding crestal bone level, follow-up showed a significant difference when comparing baseline and 6-month radiographs ($P = .00$) between the OD group, 0.908 mm ± 0.343, and the MR group, 1.3 ± 0.23 mm. ***Conclusion:*** Within the limitations of this study, the results suggest that the oversized osteotomy technique may lead to earlier implant stability and postsurgical recovery compared with the manufacturer-recommended technique for osteotomy preparation. However, further studies are needed to confirm these findings. *Int J Oral Maxillofac Implants 2021;36:771–778. doi: 10.11607/jomi.8777*

***Keywords:*** implant stability, osseointegration, oversized drilling protocol, undersized drilling protocol

As implants have become a more established treatment modality in everyday dental practice, the improvement of standard implant placement techniques becomes a necessity. It has been long established that implant stability is critical for implant success; that includes primary stability, a product of the mechanical contact between the bone and implant, and secondary stability, the biologic phenomenon produced by the progressive remodeling process.[1,2] Primary stability is influenced by a number of factors, such as bone density, quality, osteotomy preparation, and implant dimensions and design[3]; however, key among these factors are the surgical procedure by which the implant osteotomy is created and the implant microgeometry.[4] These factors influence the healing process and bone-to-implant contact (BIC); accordingly, numerous osteotomy preparation techniques and implant designs have been researched to improve stability. A key point that has not been sufficiently researched is osteotomy size. It has become common practice to adapt surgical approaches that result in an osteotomy preparation that is smaller than the diameter of the implant, which results in a tight fit between the bone and the implant surface, compressing the bone so that implants achieve higher insertion torque and higher primary stability.[5] This compaction is also thought to improve the bone quality around the implants, surrounding the implant with denser bone and allowing the implant threads to engage this bone.[6,7] This common practice has become an indication for primary stability among the manufacturer guidelines.

It is understandable that an undersized osteotomy will present higher insertion torque values compared with wider osteotomy preparations, giving greater primary stability, but research has shown that high insertion torque levels do not necessarily lead to lower system micromotion or ensure long-term success.[8,9] It

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has been suggested that high torque levels may result in high degrees of compression in the bone surrounding the implant, requiring extensive bone remodeling over time. These findings were mirrored in other in vitro studies showing differences in healing patterns with earlier apposition in sites with less pressure.[10–12] These studies raise an important question regarding the set standards of undersized osteotomy preparation and the influence this has on the osseointegration process and implant success.

The aim of the present study was to investigate the influence of oversized drilling on osseointegration and the stability of the implant. To the best of the authors' knowledge, this is the first study to investigate the effect of oversized drilling on implant stability and bone response during the osseointegration process in vivo.

## MATERIALS AND METHODS

### Study Design

The study was designed as a prospective, parallel-group, randomized controlled clinical trial. After approval by the ethical committee of the Faculty of Dentistry, Cairo University, the trial was registered on www.clinicaltrials.gov (NCT03250949).

The sample size was calculated based on a study by Cohen et al,[2] where the mean bone-to-implant contact (BIC) in the oversized drilling group was 31.5% ± 3.4% vs 16.3% ± 3.3% in the manufacturer recommended group. Accordingly, a total sample size of 12 patients was found to be sufficient to detect power of 80% and a significance level of 5%. This number was increased to a total sample size of 14 to allow for the use of the nonparametric test, then further to allow for patient attrition; the sample size was further increased to 20 implants, 10 in each group.

### Patient Selection

The patients who were enrolled by A.S. from the Periodontology Clinic, Cairo University, had one missing tooth in the posterior maxilla with sufficient bone dimensions. Included patients had to be healthy as defined by the Cornell medical index, aged between 20 and 60 years, with good oral hygiene and excellent compliance. Exclusion criteria included parafunctional habits, smoking, or pregnancy.[13]

Once eligible, the patients were provided with a full explanation of the study before signing the consent. The patients were randomized using computer-generated randomization (www.randomizer.org) by A.S. and allocated into test and control groups in a 1:1 ratio, and the allocation numbers were placed in sealed dark envelopes, which were opened by H.N. on the day of the surgery.

### Preoperative Evaluation

All patients underwent clinical examination followed by a preoperative CBCT to determine the bone height, width, and density. Radiographic stents were fabricated using cold-cure acrylic to ensure reproducibility and standardization of the periapical radiographs. The patients were randomly assigned to one of two groups:

- Control group: Manufacturer-recommended drilling group (MR), where drilling was done according to the manufacturer's guidelines
- Intervention group: Oversized drilling group (OD), where a final additional drill was used to create a wider osteotomy, ensuring the inclusion of the cortical bone

Neobiotech IS III Active implants,[1] which were used in this study, have an osteoconductive SLA-coated surface, a tapered design with a crestal macrothread design (0.8 pitch), and a self-compactable apex as well as deep threads to maximize implant stability. The implants had a platform-switch feature and a conical/hex attachment.

### Surgical Procedure

All surgical procedures were standardized and performed by a single operator (A.S.). After anesthetizing the surgical site, a full-thickness mucoperiosteal flap was raised followed by sequential drilling to create the osteotomy. The drilling was performed under copious irrigation with normal saline (800 to 1,200 rpm). All implants placed had a diameter of 4.0 mm, while the implant length was limited to 10 and 11.5 mm.

### Control: MR Group

The osteotomies were prepared according to the manufacturer's guidelines, with sequential drills ending with the drill size that corresponded to the chosen implant size. The appropriate implant was inserted manually in the osteotomy with at least 20 Ncm.

### Intervention: OD Group

Osteotomy preparation was performed according to the manufacturer's guidelines; then, an additional drill was used, 0.2 mm wider than the diameter of the implant size chosen. This last drill was inserted only half of the length of the implant (3 to 5 mm), ensuring that the implant could reach sufficient primary stability (20 Ncm) from engaging the apical bone.[2]

Implants were placed with the platform flush with the crest of the bone, a smart peg was attached to measure implant stability using an Osstell device, and mesiodistal and buccopalatal readings were taken. Healing collars were placed, allowing transgingival healing and access to the implant during the 3-month follow-up

period. The remainder of the flap was sutured by interrupted sutures.

A standardized digital periapical radiograph was taken using the custom-made radiographic stent to determine the initial crestal bone level at the day of the surgery.

Patients were instructed to apply an ice bag for 24 hours and avoid any brushing or trauma to the area for a week. Antiseptic mouthrinse (0.2% chlorhexidine oral rinse) was prescribed twice daily for 2 weeks.[14] Patients were instructed to take ibuprofen 400 mg twice daily for 3 days.

After 3 months following the implant placement and ensuring that each implant reached an ISQ value of > 70, the final screw-retained crowns were fabricated to allow retrieval for radiographic follow-ups.

Throughout the trial, triple blinding was maintained. Blinding of the participants, outcome assessor (O.T.), and biostatistician was maintained; blinding of the operator (A.S.) was not applicable.

### Outcomes

***Primary Outcome: Implant Stability.***
Implant stability was measured once at the time of implant insertion, then after 1 week, 2 weeks, 3 weeks, 4 weeks, 6 weeks, 8 weeks, and 12 weeks postoperatively. Buccal and mesial measurements were performed after placing the smart pegs.[3]

***Secondary Outcome: Crestal Bone Loss.*** Standardized digital periapical radiographs were taken on the day of the surgery (baseline), then at 3 and 6 months postoperatively. These radiographs were taken using the Minray X-ray Machine with standardized exposure parameters of 60 kVp ,10 mA, a focal film distance of 30 cm, and an exposure time of 0.08 seconds. The digital radiographs were taken using a standardized paralleling technique using a film-holding device and interchangeable bite block. The imaging plate used was a size 2 photostimulable phosphor storage plate (PSP), and the images were scanned on a Digora scanner and interpreted via Digora software[4] (Digora for Windows 2.7 imaging software; Fig 1).

The images were calibrated; then, a horizontal line parallel to and touching the implant platform was drawn. Crestal bone level was measured by drawing two vertical lines (mesial and distal to the implant), perpendicular to the parallel line just beside the implant threads. The vertical lines extended from the implant platform to the first radiopaque point representing the crestal bone.

### Postoperative Pain (Likert Scale)

Readings were recorded by the patient for the first 12 days after the surgery using the Visual Analogue Scale (VAS), which is a descriptive numerical rating scale of 0 to 10:

- 0 = no pain
- 1–3 = mild pain
- 4–6 = moderate pain (bearable)
- 7–10 = severe pain (unbearable)

### Postoperative Swelling

Readings were recorded for the first 8 days using the tissue edema index, which is a descriptive categorical rating scale of 0 to 4:

- Score 1 = absent (no swelling)
- Score 2 = slight (intraoral swelling at the operated area)
- Score 3 = moderate (moderate intraoral swelling at the operated area)
- Score 4 = intense (intensive extraoral swelling extending beyond the operated area)

### Implant Survival

Implant survival was measured at the end of the 6-month follow-up period as a binary outcome.

### Patient Satisfaction

Satisfaction with the surgical procedure and recovery was assessed at the end of the second week postoperatively. The assessment was by means of a questionnaire.

### Statistical Analysis

Statistical analysis was then performed using a commercially available software program (SPSS 18, SPSS).

Values were presented as mean and standard deviation (SD), standard error, confidence intervals, minimum, and maximum. Data were explored for normality using the Kolmogorov-Smirnov test. Data related to implant stability were parametric and thus were compared between groups using an independent *t* test and one-way analysis of variance (ANOVA) followed by the Tukey post hoc test. Values of pain, swelling, and crestal bone level showed a nonparametric distribution, and the Friedman test and Mann-Whitney *U* test were used to compare the data between both groups. The level of significance was set at $P < .05$.

## RESULTS

Twenty patients were recruited for the study, and 20 implants were placed; however, only 18 implants were investigated, as one split-mouth patient declined to continue the study after implant placement. The patients recruited for the study included 15 women and 3 men with a mean age of 40.5 years.

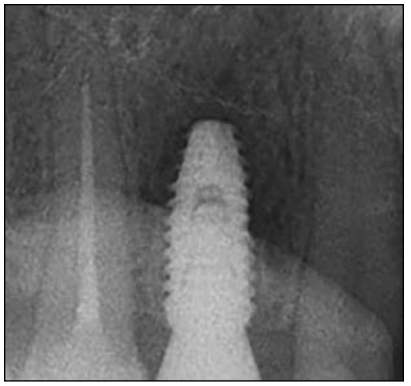

**Fig 1** Periapical radiograph with evidence of oversized drilling.

**Table 1 Descriptive Statistics and Comparison in Different Observation Times Within the Control Group (ANOVA Test)**

| | | | | 95% confidence interval for mean | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Standard error | Lower bound | Upper bound | Min | Max | F | *P* |
| Week 0 | 70.29[a] | 3.75 | 1.42 | 66.82 | 73.75 | 66.20 | 75.60 | 9.05 | .00* |
| Week 1 | 67.03[a,b] | 5.99 | 2.27 | 61.49 | 72.57 | 56.60 | 73.80 | | |
| Week 2 | 61.71[a,b,c] | 6.78 | 2.56 | 55.44 | 67.98 | 50.00 | 68.40 | | |
| Week 3 | 59.86[b,c] | 6.09 | 2.30 | 54.23 | 65.49 | 50.20 | 67.40 | | |
| Week 4 | 53.63[c] | 6.58 | 2.49 | 47.55 | 59.71 | 42.00 | 62.60 | | |
| Week 6 | 55.69[c] | 5.12 | 1.93 | 50.95 | 60.42 | 46.20 | 61.40 | | |
| Week 8 | 59.77[b,c] | 4.91 | 1.85 | 55.24 | 64.31 | 52.40 | 66.40 | | |
| Week 12 | 69.51[a] | 3.46 | 1.31 | 66.31 | 72.72 | 65.40 | 74.20 | | |

Significance level, $P < .05$; *significant.
Tukey post hoc test: means sharing the same superscript letter are not significantly different.

## Implant Stability

During the first 4 weeks, the MR group showed a decrease in mean implant stability quotient (ISQ) values. The mean ISQ value obtained immediately postoperative was 70.29 ± 3.75, compared with the reading obtained week 1, 67.03 ± 5.99, through week 4, 53.63 ± 6.58. The mean ISQ values then showed a gradual increase in weeks 6 through 12 up to 69.51 ± 3.46. The ANOVA test revealed that the difference between observation times was statistically significant ($P = .0001$), but the Tukey post hoc test revealed that the difference between baseline, week 1, week 2, and week 12 was not statistically significant, as illustrated in Table 1.

In comparison, the intervention group (OD), showed a mean gradual increase in ISQ value over the follow-up period from baseline, 52.36 ± 10.80, to week 12, 77.57 ± 0.96. The ANOVA test revealed that the difference between observation times was statistically significant ($P = .0001$); however, the Tukey post hoc test revealed the difference between the follow-ups. When comparing the two groups at week 0 and week 1, a higher mean value was recorded in the MR group, with a significant difference ($P = .00$, $P = .04$, respectively). Starting from week 2, a higher mean value was recorded in the intervention group, as illustrated in Fig 1 with a statistically significant difference ($P = .04$), and a similar pattern was detected at weeks 3, 4, 6, 8, and 12, with a higher mean value recorded in the intervention group, which was found to be statistically significant ($P = .0059$; Table 2). When comparing the two groups (Table 3), there was a statistically significant difference throughout the follow-ups.

## Crestal Bone Level

At baseline, there was a higher mean crestal bone level in the MR group, 0.350 ± 0.174, compared with 0.261 ± 0.165 in the intervention group, with no statistically significant difference between the groups ($P = .15$). At 3 months, there was a higher mean value in the MR group, 0.693 ± 0.144, compared with the intervention group, 0.522 ± 0.216, with no statistically significant difference between the groups ($P = .20$). However, at the 6-month follow-up, there was a significant difference ($P = .00$) between the intervention group, 0.908 ± 0.343 mm, and the MR group, 1.3 mm ± 0.23 (Tables 4 and 5).

**Table 2 Descriptive Statistics and Comparison in Different Observation Times Within the Intervention Group (ANOVA Test)**

| | | | | 95% confidence interval for mean | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Standard error | Lower bound | Upper bound | Min | Max | F | *P* |
| Week 0 | 52.36[d] | 10.80 | 3.60 | 44.06 | 60.65 | 37.60 | 65.40 | 22.05 | .00* |
| Week 1 | 59.69[c] | 6.52 | 2.17 | 54.68 | 64.70 | 52.40 | 69.60 | | |
| Week 2 | 68.78[a,b] | 4.72 | 1.57 | 65.15 | 72.40 | 63.40 | 76.20 | | |
| Week 3 | 70.98[a,b] | 2.95 | 0.98 | 68.71 | 73.24 | 68.00 | 78.20 | | |
| Week 4 | 73.29[a,b] | 3.27 | 1.09 | 70.78 | 75.80 | 69.40 | 80.00 | | |
| Week 6 | 73.94[a,b] | 2.56 | 0.97 | 71.57 | 76.31 | 70.60 | 77.60 | | |
| Week 8 | 75.69[a,b] | 1.90 | 0.72 | 73.93 | 77.44 | 72.40 | 78.00 | | |
| Week 12 | 77.57[a] | 0.96 | 0.36 | 76.68 | 78.46 | 76.40 | 79.00 | | |

Significance level: $P < .05$; *significant.
Tukey post hoc test: means sharing the same superscript letter are not significantly different.

**Table 3 Comparison Between Control and Intervention Group (*t* test)**

| | | | | | | 95% confidence interval of the difference | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean difference | Standard difference | Lower | Upper | *t* | *P* |
| Week 0 | Control | 70.29 | 3.75 | | | | | | |
| | Intervention | 52.36 | 10.80 | 17.93 | 3.87 | 9.35 | 26.51 | 4.64 | .00* |
| Week 1 | Control | 67.03 | 5.99 | | | | | | |
| | Intervention | 59.69 | 6.52 | 7.34 | 3.14 | .58 | 14.10 | 2.34 | .04* |
| Week 2 | Control | 61.71 | 6.78 | | | | | | |
| | Intervention | 68.78 | 4.72 | –7.06 | 3.01 | –13.74 | –0.39 | –2.35 | .04* |
| Week 3 | Control | 59.86 | 6.09 | | | | | | |
| | Intervention | 70.98 | 2.95 | –11.12 | 2.50 | –16.87 | –5.38 | –4.45 | .00* |
| Week 4 | Control | 53.63 | 6.58 | | | | | | |
| | Intervention | 73.29 | 3.27 | –19.66 | 2.71 | –25.88 | –13.44 | –7.25 | .00* |
| Week 6 | Control | 55.69 | 5.12 | | | | | | |
| | Intervention | 73.94 | 2.56 | –18.26 | 2.16 | –23.16 | –13.35 | –8.44 | .00* |
| Week 8 | Control | 59.77 | 4.91 | | | | | | |
| | Intervention | 75.69 | 1.90 | –15.91 | 1.99 | –20.52 | –11.31 | –8.01 | .00* |
| Week 12 | Control | 69.51 | 3.46 | | | | | | |
| | Intervention | 77.57 | .96 | –8.06 | 1.36 | –11.28 | –4.84 | –5.93 | .00* |

Significance level: $P < .05$; *significant.

## Pain Score

At days 0, 1, 2, and 3, 57.1% of patients in the MR group recorded score 2, 28.6% recorded score 3, and 14.3% recorded score 0. In comparison, 100% scored 0 in the intervention group. The chi-square test revealed a significant difference between both groups ($P = .006$). In the subsequent days, both groups recorded 100% score 0, with no difference between groups ($P = 1$).

## Swelling

On days 1, 2, 3, and 4, only two patients of the MR group had slight swelling, while in the intervention group, no swelling was reported. The chi-square test revealed that the difference between both groups showed no statistical significance ($P = .086$). At baseline and from days 5 to 14, both groups recorded 100% absence of swelling, with no difference between groups ($P = 1$).

## Implant Survival

Both groups showed a 100% survival rate throughout the follow-up period, with no difference between the groups and with no complications observed.

**Table 4 Descriptive Statistics and Comparison of Digora Results Between Different Observation Times Within the Same Group (ANOVA test)**

| | | | | 95% confidence interval for mean | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Standard error | Lower bound | Upper bound | Min | Max | F | *P* |
| **Control** | | | | | | | | | |
| Baseline | .350[c] | .174 | .047 | .249 | .451 | .100 | .600 | 50.2 | .00* |
| 3 mo | .693[b] | .144 | .038 | .610 | .776 | .500 | .900 | | |
| 6 mo | 1.339[a] | .234 | .063 | 1.203 | 1.474 | 1.100 | 2.000 | | |
| **Intervention** | | | | | | | | | |
| Baseline | .261[c] | .165 | .039 | .179 | .343 | .100 | .600 | 14.89 | .0001* |
| 3 mo | .522[b] | .216 | .051 | .415 | .629 | .100 | 1.000 | | |
| 6 mo | .908[a] | .343 | .081 | .737 | 1.079 | .500 | 1.500 | | |

Significance level: $P \leq .05$; *significant.
Tukey post hoc test: means with different superscript letters are significantly different.

**Table 5 Descriptive Statistics and Comparison of Digora Results Between Control and Intervention Group at Each Observation Time (Independent *t* test)**

| | | | | Difference | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Standard error mean | Mean | Standard error | CI lower | CI upper | *t* | *P* |
| **Baseline** | | | | | | | | | |
| Control | 0.350 | 0.174 | 0.047 | 0.09 | 0.06 | −0.03 | 0.21 | 1.48 | .15 ns |
| Intervention | 0.261 | 0.165 | 0.039 | | | | | | |
| **3 mo** | | | | | | | | | |
| Control | 0.693 | 0.144 | 0.038 | 0.17 | 0.07 | 0.03 | 0.31 | 2.55 | 0.20 ns |
| Intervention | 0.522 | 0.216 | 0.051 | | | | | | |
| **6 mo** | | | | | | | | | |
| Control | 1.339 | 0.234 | 0.063 | 0.43 | 0.11 | 0.21 | 0.65 | 4.02 | .00* |
| Intervention | 0.908 | 0.343 | 0.081 | | | | | | |

CI: 95% confidence interval.
Significance level $P \leq .05$; *significant; ns = nonsignificant.

### Patient Satisfaction

From day 0 to day 14, both groups recorded 100% satisfaction, with no difference between groups ($P = 1$).

### Harm

None of the patients was harmed within the process of the study.

## DISCUSSION

There is a need to investigate all aspects of implant placement procedures in order to improve on an already-established process. The present study aimed to investigate the influence of oversized drilling compared with manufacturer-recommended drilling techniques with regard to implant stability, crestal bone loss, and implant survival.

During implant placement, an array of factors affect implant stability, such as implant diameter, length, design, and even placement region. Implants chosen for the study were of a single design and diameter, while the length was limited to two options (10 mm and 11.5 mm) in order to limit any heterogeneity.[15,16] Implants placed were limited to the posterior maxilla to homogenize the placement location and avoid any influence the bone type might have on the results. All aspects of the drilling procedure were standardized in the study design to decrease some of the confounding variables.

Implant placement followed the manufacturer's guidelines; however, in the OD group, an extra drill was inserted to widen the osteotomy by 0.2 mm, as gaps lower than 0.35 mm are close to the critical gap width for direct lamellar bone apposition and wide enough to prevent compressive forces on the bone.[17] The implant

design choice was due to its thread design, which allows higher primary stability.

Follow-up was done using resonance frequency analysis (RFA) technology, as it is an effective tool for monitoring implant stability progress during healing. The increase in ISQ value over time is considered a reflection of bone apposition.[18,19] The choice not to focus on the insertion torque was due to evidence suggesting that peak insertion torque (PIT) values merely measure the frictional resistance of an implant to rotation and not axial stability.[18] There is a scarcity of data in the literature describing measurable early secondary stability during the healing process.[20]

At baseline and the first week postoperative, the OD group (52.36 ± 10.80; 59.69 ± 6.52) exhibited ISQ values that were statistically lower than the MR group (70.29 ± 3.75; 67.03 ± 5.99). The lower ISQ value of the OD group corresponded to a lower insertion torque due to the decreased initial BIC and to the influence of the cortical bone on the resonance frequency results. A strong correlation between the cortical bone thickness and ISQ values has been observed.[21] However, in week 2, there was a paradigm shift in the ISQ values of the OD group, which increased significantly to reach 68.78 ± 4.7 ($P$ = .04) and in week 3, 70.9 ± 2.9 ($P$ = .0), while the MR group exhibited a decrease in week 2 (61.71 ± 6.78) and week 3 (59.86 ± 6.09). This difference between the two groups remained until the last follow-up at 12 weeks despite the consistent increase in the ISQ values in the MR group.

This statistically significant decrease in ISQ observed for the MR group starting from the second week lasted until the fourth week after the implant placement. The ISQ values then started to increase progressively after the fourth week. These results are in agreement with other studies that noted a decrease in ISQ values as primary stability is lost, and the recovery reflects the establishment of secondary stability.[22] In the MR group, the process of osseointegration seems to begin only after bone resorption[23] at the contact points between the implant and surrounding bone, leading to a decrease in primary stability that is followed by new bone formation.[24–27] Undersized drilling creates significant areas of compression along with the bone-implant interface that may create microcracks. Damage sustained by these forces results in areas of necrosis that require resorption, resulting in the subsequent loss of primary stability.[26] The damaged osteocytes activate osteoclasts resorbing bone in areas of damage, therefore delaying osseointegration. This delay inevitably leads to a decrease in primary stability for a short period of time[1] and a corresponding decrease in ISQ values.[4,12]

In contrast, the early and progressive increase in ISQ values in the OD group over the follow-up period suggests that bone apposition begins reflecting the establishment of adequate secondary stability in a shorter time frame, which could allow earlier loading. The space between the implant and the bone allows early intramembranous-like bone formation according to Marin et al,[28] who showed that healing chamber size does play a role in bone healing at early implantation times. A closed chamber between the implant and the bone allowed blood fill and subsequent new bone formation compared with press-fit conditions, where there was little to no space between the implant and bone immediately after placement.[23,29] In the oversized group, the healing process at the implant-bone interface revealed more newly formed bone growth directly within the implant threads.[11] The osseointegration process is relatively short for an implant that exhibits a large contact-free surface compared with an implant with a large contact surface. Creating a minimal gap between the implant and the osteotomy may be beneficial.[17,23]

Crestal bone changes were monitored by parallel periapical radiographs during a 6-month period. The crestal bone loss in both groups resulted in a significant increase over the 3- and 6-month period. There was no significant difference between the groups in CBL at the baseline nor at the 3-month follow-up. However, at the 6-month follow-up, there was a significant difference ($P$ = .00) between the intervention group, 0.908 ± 0.343 mm, and the MR group, 1.3 mm ± 0.23, that may be explained by the oversized drilling protocol being combined with decreased stresses. However, if the decreased stresses are the cause of the decreased crestal bone resorption, this should have been seen in the 3-month follow-up. Furthermore, the small sample size and the short follow-up period of the study could be deceiving regarding the crestal bone resorption.[11,12] Moreover, the crestal bone resorption difference of 0.4 mm between the two groups could be deemed of minimal clinical significance.

Regarding the patient-reported outcomes, there was no difference between both groups in both implant survival and patient satisfaction, with both showing 100% survival and satisfaction. Only two patients reported slight swelling in the MR group, which on questioning was attributed to failure to adhere to the postoperative instructions. On the other hand, the pain score was higher in the initial phases of recovery in the MR group during the first 4 days of healing compared with the intervention group. Two of these patients who showed swelling failed to follow the postoperative instructions, leading to increased pain perception (score 3). The remainder of the patients who showed increased pain scores (score 2) may be attributed to the trauma from the pressure of undersized drilling taking place in the MR group vs the intervention group, where recovery may proceed at a faster pace.

### Limitations

The short follow-up of the study cannot predictably reflect accurate survival rates in such a time frame. Moreover, the radiograph follow-ups should have been expanded to at least 1 year. However, the main aim of the present study was to focus on the osseointegration period of the implant. Furthermore, the relatively small sample size needs to be expanded and to include other anatomical areas.

## CONCLUSIONS

Within the limitation of this study, the results indicate that the oversized osteotomy technique may show promise in clinical application. The results suggest that implant stability and postsurgical recovery may be improved, proceeding at a faster pace compared with undersized osteotomy preparation. However, further studies are needed to confirm these findings.

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