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EVALUATION OF DIFFERENT DRILLING PROTOCOLS EFFECT ON BONE HEALING AROUND DENTAL IMPLANT USING CBCT

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ABSTRACT

Objective: The objective of the present study is to analyze and compare the effect of different implant drilling protocols on host bone and measure them using CBCT. **Subjects and Methods:** Twenty patients with Kennedy class III modification 1 edentulous areas were recruited for this study and divided into two groups; Control group received implants with conventional osteotomy preparation following standard drilling protocol (speed= 1200 rpm) with torque of 30 N and sufficient saline irrigation, while Study group received implants with osteotomy preparation following a low speed drilling protocol (speed < 200 rpm) without irrigation and a torque of 50 N. Cone Beam CT was used to evaluate bone height and density around the implants at 3, 6 and 12 months after insertion. Implant primary stability was evaluated using Ostell by Resonance Frequency Analysis. **Results:** No significant difference was showed between bone height changes and densities in the control and study groups. Implants primary stability also showed no significant difference in ISQ values between both groups. **Conclusion:** Biologic drilling is a promising implant drilling protocol with the potential to insert implants showing successful osseointegration and acceptable bone changes.

KEYWORDS: Dental Implant, CBCT, Bone Healing

INTRODUCTION

Dental implants are now the successful treatment option for edentulism. Recent studies and techniques arise to increase the chances of success of dental implants [(1)]. Bone quality and quantity are direct factors affecting the success or failure of implants. Keeping this in consideration, it is difficult to place the implant in a prosthetically driven position, as desired by implantologists now [(2)]. To achieve that, it requires the use of bone augmentation procedure either during or before implant insertion.

Upon authors knowledge there are many bone regenerative materials available now, however, they showed variable degrees of success and no ideal material has been developed yet [(3)]. Bone necrosis is expected to occur during osteotomy only if host bone is exposed to a temperature of 47°C for 1 minute. Studies have proven that in the absence of irrigation, the recorded bone temperature range was 31.4°C to 36.9°C when drilling at the speed of 188 rpm, and 35.2°C to 43.0°C when drilling at the speed of 462 rpm [(4)].

The ability to harvest bone chips from the site of the osteotomy without being washed away is the main advantage of low speed drilling without being washed away by irrigant. Yet it has also been suggested that low speed drilling preserve vital osteocytes, thus maintaining the bone's regenerative

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potential [5]. The best type of bone grafts is autografts because of their proven osteogenic, osteoconductive and osteo inductive capabilities [6].

However, autografts disadvantage is the necessity of a donor site, with substantial size amount of bone required, and is sometimes harvested from extraoral sites causing the patient to suffer further pain and donor site morbidity [7].

In implant osteotomies, the use of bone chips collected during surgical drilling can substitute an autograft it can be obtained during the low-speed drilling protocol (also called biologic drilling), where they are attached to the drill during surgery and can be harvested due to the absence of external irrigation. In the absence of irrigation, this low-speed drilling technique avoids causing bone necrosis by creating a temperature below 47 C due to reduced frictional heat generation [8,9].

The present study was carried out to analyze and compare clinically and radiographically the different drilling protocols of implant osteotomies on recipient bone and implant primary stability. The aim of this study is to assess the effect of drilling protocols on peri-implant bone level and implant primary stability clinically and radiographically.

SUBJECTS AND METHODS

The patients participating in this controlled, randomized clinical study were recruited from the Hospital of The British University in Egypt and signed an informed consent. Ten patients participated in this study, ranging in age from Forty to Sixty-five years. Each patient received 2 posterior implants placed by both drilling techniques, for a total of 10 implants for each group [1].

Patients' privacy was adequately protected and all data collectors and investigators except the principal researcher were blinded to the patients' information.

Inclusion Criteria: Patients that are partially edentulous with a mandibular Kennedy class III modification 1 configuration and have been partially edentulous for one to three years. Implant retained prostheses were constructed for all patients using the same techniques of construction. Any extractions or surgeries performed at least 6 months earlier.

Exclusion Criteria were patients with systemic diseases affecting bone quality or resorption, temporomandibular joint dysfunction, severe attrition or parafunctional habits, patients undergoing radiotherapy or chemotherapy, heavy smokers, and vulnerable groups like psychologically unstable patients [10].

Each patient received two mandibular implants, one implant inserted following conventional drilling protocol (Control Group) and the other implant following biologic drilling technique (Study Group). For the control group, all implants were inserted following conventional drilling technique; speed of 1200 rpm, torque at 30 N, and copious saline irrigation.

For the study group, all implants were inserted following slow drilling technique; speed of 150rpm, torque at 50 N, and no irrigation, for an uninterrupted drilling time of less than 60 seconds. Delayed loading protocol was followed for both groups where implant prosthesis was constructed and delivered to the patient 4 months after implant insertion.

Surgical Procedures:

All surgeries were performed with strict aseptic and infection control measures and were performed by the same surgeon. After inferior alveolar and lingual nerve block anesthesia, a crestal incision was made using no.15 blade and a mucoperiosteal flap was elevated. Osteotomies were drilled at 150 rpm with sequential drills without irrigation for the study group implants and 1200 rpm with irrigation for the Control group implants.

For the implants drilled at 150 rpm, bone chips were collected from each drill manually by a sterile excavator and collected in a petri dish. After drilling was finished bone ships were all recollected and inserted in the osteotomy.

Implants (Vitronix, Italy) with different sizes were placed according to diameter and length of available bone (figures 1 and 2) and the flap was sutured using size 3.0 silk sutures.

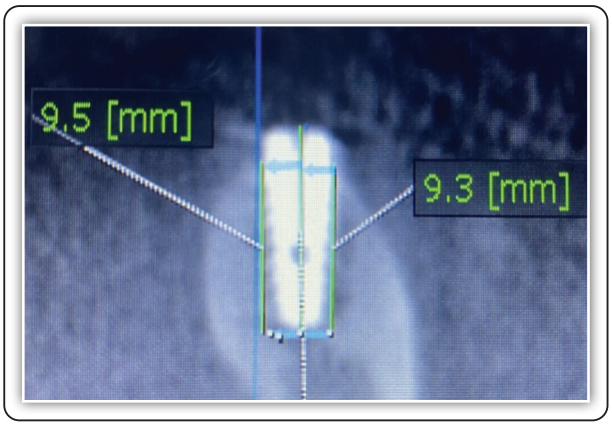

FIG (1) Implant at insertion

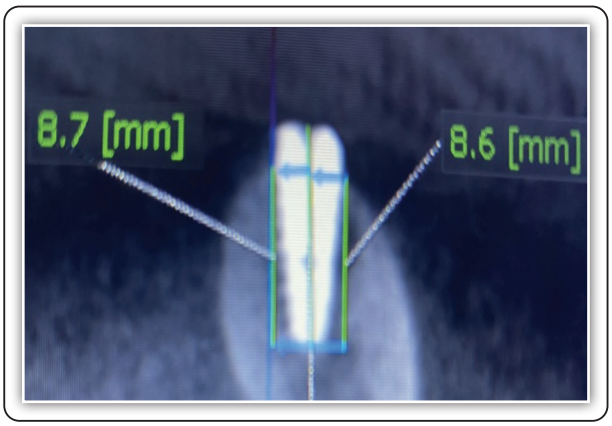

FIG (2) Bone changes after 6 months

Prosthetic Procedures

Prosthetic procedures were carried out every 4 months using Cone Beam CT (Planmeca Viso G7, Helsinki, Finland) and (Romexis 6.4.7) software was used to evaluate the bone height changes around implant sites, after implants insertion, following a delayed loading protocol.

Primary impressions were taken in suitable sized stock trays using alginate (Cavex, Haarlem, Holland) and poured to make study casts upon which special trays were constructed. Secondary impressions were taken using the open tray technique after mounting the impression copings (Vitronix, Italy) on the implants.

Master casts were then poured, and after recording the Jaw relation and taking face bow records, these casts were mounted on a semi adjustable articulator, (Dentatus, Stockholm, Sweden) where the teeth were set, and the occlusion was properly adjusted.

Prosthesis delivery was then carried out.

Evaluation method

Measuring Primary stability

After surgical procedures, a Smart Peg was mounted onto each implant, and an Ostell device (Ostell AB, Goteborg, Sweden) was used to measure implant primary stability. The measurements were performed in the buccal, lingual, mesial and distal directions, and a mean value of those 4 readings was considered the implant's primary stability in Implant Stability Quotients. (ISQ) (Figure 3)

FIG (3) Osstell for measuring implant primary stability

CBCT measuring Bone Changes

Cone Beam CT (Planmeca Viso G7, and (Romexis 6.4.7) software was used to evaluate the bone height changes around implant sites, for both implant groups. Cone beam CT was carried out at implant insertion, 3 months, 6 months and 12 months.

A tangential line on the base of the implant and other lines on the highest point buccal, lingual, mesial, and distal were put and the distance between them was measured.

Peri-implant Bone density was evaluated in this study as a secondary outcome, using Cone Beam CT at 0, 3 and 12 months. The designated area that was analyzed was up to 1mm distance from the implant in all 4 directions, and an average value was taken as a representative of peri implant bone density. The data was collected and statistically analyzed.

Statistical analysis

Numerical data were tested for normality using Shapiro-Wilk's test. Data were parametric so they were presented as mean and standard deviation (SD) values and independent t-test was used to analyze intergroup comparisons while repeated measures ANOVA followed by Bonferroni post hoc test was used to analyze intragroup comparisons. The significance level was set at $p<0.05$ within all tests. Statistical analysis was performed with R statistical analysis software version 4.1.2 for Windows.

RESULTS

Results of inter and intragroup comparisons of bone height change presented in table (1) and in figures (4) and (5) showed that at all intervals and overall, there was no significant difference between both groups ($p>0.05$). In addition, for the study group there was no significant difference between values measured at different intervals ($p=0.166$), while for the control group the difference was statistically significant with the change between (baseline-3 months) being significantly higher than the difference between (3-6 months) ($p<0.001$).

Results of intergroup comparisons of implant primary stability presented in table (2) and in figure (6) showed that there was no significant difference between both groups ($p=0.533$).

TABLE (1) Inter and intragroup comparisons of bone height change (mm)

Interval	Bone height change (mm) (Mean±SD)		p-value
	Study	Control	
Baseline-3 months	0.40 ± 0.08^{A}	0.45 ± 0.05^{A}	**0.167**
3-6 months	0.34 ± 0.06^{A}	0.32 ± 0.05^{B}	**0.421**
6-12 months	0.41 ± 0.08^{A}	0.38 ± 0.09^{AB}	**0.405**
Overall	0.38±0.08	0.38±0.08	**0.937**

*Different superscript letters indicate a statistically significant difference within the same vertical column; *significant ($p<0.05$)*

TABLE (2) Inter and intragroup comparisons of implant primary stability (ISQ)

Primary stability (ISQ) (Mean±SD)		p-value
Study	**Control**	
62.10±2.47	61.40±2.46	**0.533**

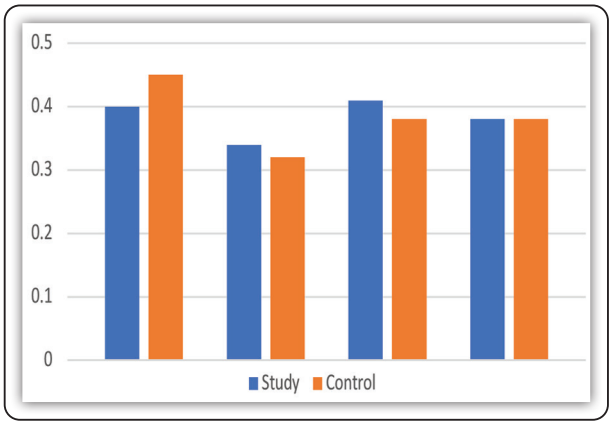

FIG (4) Bar chart showing mean and standard deviation values of bone height change (mm)

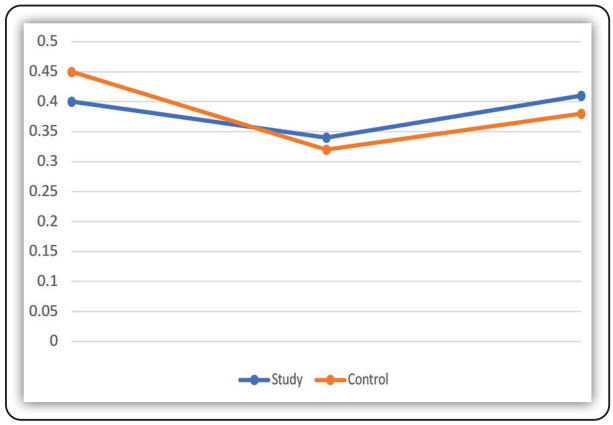

FIG (5) Line chart showing mean and standard deviation values of bone height change (mm)

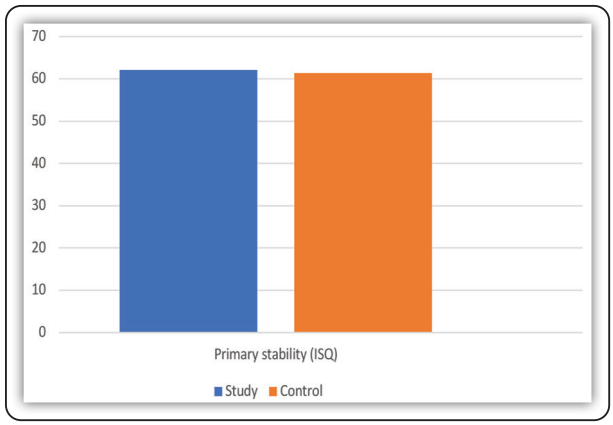

FIG (6) Bar chart showing mean and standard deviation values of implant primary stability (ISQ)

DISCUSSION

Biologic drilling in implant osteotomies has proved to have several advantages; besides the ability to collect bone chips to use as an autograft, the technique allows for a better visibility during drilling due to the absence of irrigation [11].

The greatest concern regarding this technique is the temperature rise caused by drill friction in the bone which could cause bone necrosis and implant failure. The results of this study indicated no significant differences in bone height changes and density between the study group and control group, proving that no bone necrosis has occurred during drilling in the absence of irrigation.

This is in accordance with other studies which indicated that, following proper slow drilling protocol of not exceeding a temperature of 47 C°, no statistically significant differences were found between both drilling techniques [12].

The results also showed statistically significant peri implant bone changes in the control group between 0-3 months. This could possibly be attributed to the fact that bone remodeling is at its maximum during the first three months after implant insertion, and bone initially formed around the implant, which presents characteristics of spongy bone, is gradually resorbed until it disappears at the end of 90 days, when it is completely replaced by compact bone [13,14].

The fact that this change was statistically insignificant in the study group maybe due to the proven fact that in comparison to bone substitutes, autogenous bone (in this case the bone chips collected and added during the slow drilling osteotomy) enabled faster initial bone formation, but the final amount of bone formation did not differ from that observed with bone substitutes[15,16].

Another cause of the significantly different change in the control group between 0-3 months could be that conventional bone drilling has been known to cause some bone damage in some cases when irrigation was unable to reach the final part of the neo alveolus [17-20]. Yet studies have proved that drilling procedures resulting in heat generation that could cause implant failure are rare as long as basic guidelines are followed [21].

Other factors that may play a role in the success of the biologic drilling technique include the type of bone itself; cortical bone has low thermal conductivity and is less able to dissipate heat produced during drilling, whereas medullar bone, known for its higher vascularization, has a greater ability to dissipate heat [22].

In this study, implant primary stability was measured using the Osstell ISQ system by the Resonance Frequency Analysis (RFA) method. RFA values are directly proportional to the implant stiffness in the bone, particularly during initial healing phase, and is an initial indicator of long-term prognosis. Having showed no significant difference between the primary stability of implants in both groups indicates that the biologic drilling technique is a potentially successful method to insert implants[23].

CONCLUSION

Within the limitations of this study, we can conclude that biologic drilling is a successful implant drilling protocol that has a potential to insert long term surviving implants, with similar prospects to the conventional drilling protocol.

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