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# Comparative assessment for osseodensification versus conventional surgical technique in low density bone

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***Abstract:***

***Background****: Primary stability is one of the fundamental criteria for obtaining osseointegration. It depends on different factors, the implant design, surgical technique, bone density, and on the microscopic and macroscopic morphology of the implant used3. High primary stability is easily obtained in dense bone, thus providing contact osteogenesis. Osseodensification technique is an innovative technique to increase the bone density during the drilling process in which the drill designing allows the creation of an environment that increases the initial primary stability through densification of the osteotomy site walls by means of non-subtractive drilling. This study was directed to Investigate the efficacy of osseodensification as a new bone drilling concept in low density bone and to compare the effect of osseodensification versus conventional drilling on the primary stability and osseointegration of implant.*

***Materials and Methods****: seven female subjects aged from 40 to 59 years who fulfilled the inclusion criteria were selected. 14 implants placed in a split mouth design as follow Osseodensification group:7 implants were placed using Densah bur kit in one side. Conventional group: 7implants were placed using conventional bur kit in the other side. Patients were followed up clinically and radiographically by CBCT for 12 months*

***Results****: No valuable difference existed between the two groups regarding the primary and secondary stability, plaque index, bleeding on probing, pocket depth and marginal bone loss except bone density, statistically significant difference in bone density in favor of osseodensification group immediately after surgery.*

***Conclusion:*** *Osseodensification showed enhancement of bone density by the novel Densah bur that work safely in low density bone and decrease the possibility of creating bone dehiscence. CBCT advantageous preoperatively for determining the bone density also postoperatively can adequately measure the bone architecture and density around implants. Based on advantageous present study results, osseodensification technique is reliable method to enhance the rapid healing and maintain the marginal bone integrity after load.*

***Key Word****: osseodensification, low density bone and primary stability*

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## I. Introduction

Lekholm&Zarb classification is considered the most accepted classification of bone quality[1]. This classification is based on the amount of cortical and trabecular bone shown in preoperative radiographs generating four scores: I, II, III and IV. It has been assumed that bone quality is equivalent to bone mineral density[2].

Primary stability is one of the fundamental criteria for obtaining osseointegration. It depends on different factors, the implant design, surgical technique, bone density, and on the microscopic and macroscopic morphology of the implant used[3]. High primary stability is easily obtained in dense bone, thus providing contact osteogenesis. In low density bone, it is often difficult to obtain satisfactory primary stability. The lack of initial stability can result in distant osteogenesis, a longer healing period, and a lower success rate[4].

Posterior maxilla often present with more or less dense trabecular bone surrounded by a thin layer of cortical bone (class III and IV).In this biologically challenged region for implant placement, it is often difficult to achieve good primary stability. It could be achieved by the undersized preparation technique, wider implant diameter, placement of conical implants [4], bone compaction through osteotomes[5], the technique of the expanders[6], piezo surgeries[7], lately the new osseodensification drilling technique[8]

Osseodensification technique is an innovative technique to increase the bone density during the drilling process in which the drill designing allows the creation of an environment that increases the initial primary stability through densification of the osteotomy site walls by means of non-subtractive drilling. The rationale for

the utilization of this process is that densification of the bone that will immediately be in contact to the endosteal device will not only result in higher degrees of primary stability due to physical interlocking (higher degrees of contact) between the bone and the device, but also in faster new bone growth formation due to osteoblast nucleating on instrumented bone that is in close proximity with the implant[9].

While osseodensification drilling process have been demonstrated in vitro, animal studies and recently in few human studies[9&10] and proved greater outcome in increasing the primary stability of implant placed in normal bone. However primary stability in low density bone is challenging procedure. The primary objective of this study is to investigate the effect of the osseodensification drilling process versus the conventional drilling.

## II. Material And Methods

Seven female subjects with bilateral posterior edentulous maxilla were selected from outpatient clinic of the Department of Oral Medicine, Periodontology, Oral Diagnosis, and Radiology, Faculty of Dentistry, Tanta University to participate in the present study. Their ages ranged from 40 to 59 years with a mean age of 49.5 years.

Fourteen implants were placed with two different surgical techniques in a split mouth design. Each patient received implants with two different drilling techniques in a split mouth design.

**Implant Placement procedures:-**

**I) Preoperative Assessment**

All patients were evaluated in the following manner:

I- History:

Patient's charts were reviewed for information about

Personal data (name, age. Sex……..)

Past medical history.

Past dental history.

**2- Preoperative preparation**

All patients were subjected to proper oral hygiene instructions, scaling and root planning for all teeth and periodontal treatment if needed to provide an oral environment more favorable to wound healing.

Diagnostic study models were made and transferred to articulator for analysis and fabrication of a surgical template for guiding the position and axis of implant fixtures11.

Radiographic evaluation, Cone beam computed tomography (CBCT) was taken preoperatively to determine the density of surgical site12

As prophylactic measures, all patients were received 1g amoxicillin and 4mg dexamethasone one hour before surgery.

**II) Surgical technique:**

Perioral areas were aseptically prepared. The maxillary surgical sites were infiltrated with local anesthesia containing vasoconstrictor. After appropriate incisions were made, full-thickness buccal and palatal mucoperiosteal flaps were reflected. Rt side: conventional drilling group: (control group), implant site preparations were performed by pilot and spiral drills to reach the final diameter according to the manufacturer's standard protocol.

Lt side: osseodensification group: (test group):

1-Osteotomy site was prepared with a point (guide) drill to the desired depth (clockwise direction).

2- The drill motor was changed to reverse counterclockwise (densifying mode).

3-We begin with the narrowest diameter till reaching the desired width for implant placement

For both groups the cover screws were placed and tightened to seal the internal hex of the implant. The gingival incisions were closed by interrupted and periodontal dressings were placed.

**III) Post-operative care:**

All subjects were received post-operative instruction including, rinsing with 0.1% chlorhexidine (Twice daily for 2 weeks). A combination antibiotic therapy, Amoxicillin/Clavulanate 375 mg tablets and Metronidazole 250 mg tablets both for 3/days and systemic anti-inflammatory for 1 week were administrated. Periodontal dressing and suture removal were performed after 14 days according to criteria of Horwitz et al.,[13].

**IV) Prosthetic phase:**

After 6 months, the implant fixture was exposed and the healing caps were positioned for two weeks for both groups Then the abutments were inserted

**Clinical and radiographic assessment:**

| Type of assessment | Before implant placement | Immediately after implantation (base line) | At 6 months | At 7 months | At 12 month |
|---|---|---|---|---|---|
| Plaque score | | | | * | * |
| Probing depth | | | | * | * |
| Bleeding on probing | | | | * | * |
| Implant stability | | * | * | | |
| -Marginal bone level around the implant | | * | | * | * |
| Density of bone. | * | * | | * | * |

**Statistical analysis**

Numerical variables are expressed by descriptive statistics as mean, standard deviation and range. Paired t-test was used to pre and post within group. Independent t-test was used to compare the two groups. P-value <0.05(*) was considered significant difference & P-value <0.001(**) was considered highly significant difference. Statistical analyses were performed using Statistical Package for Social Sciences (SPSS version 26).

## III. Result

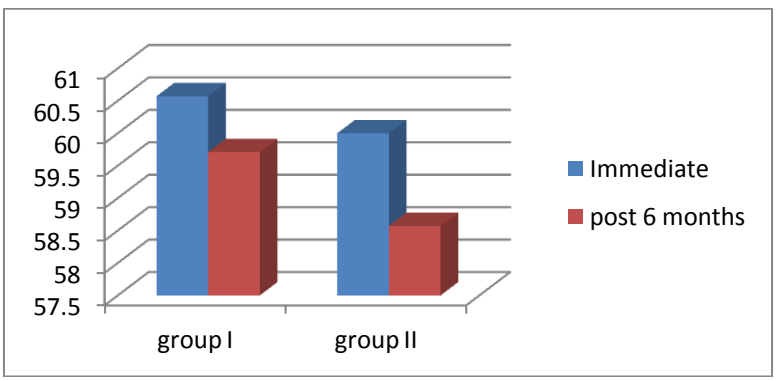
I- Clinical Evaluation Results:

Patients were evaluated immediately post surgically and at 6 months for implant stability. While at 7 &12 months postoperatively for plaque index (PI), probing depth (PD) & bleeding on probing (BOP)

The implant stability quotient (ISQ) of osseodensification group and conventional group respectively were (60.6±2.3) & (60.00±9.09) at the base line, there was no statistically significant difference between the two groups at base line. Surprisingly after six months the ISQ values were (59.7±7) & (58.6±4.6) for osseodensification group and conventional group respectively. There was no statistically significant difference between the two groups.

**Table no 1:** Intra-group comparison of ISQ immediately & post 6 months of implant placement.

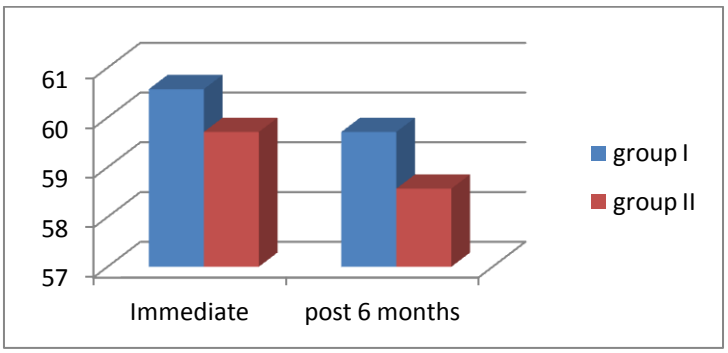
| ***Immediate versus post 6months*** | (M±SD) ***immediate*** | (M±SD)***Post 6months*** | ***T test value*** | ***P value*** |
|---|---|---|---|---|
| ***Group I*** | 60.57±12.33 | 59.71±6.99 | 0.19 | 0.85 ns |
| Group II | 60.00±9.09 | 58.57±4.65 | 0.38 | 0.71 ns |




Statistical analysis showed no significant difference between ISQ values for each bone types at each follow-up.

**Table no2:** Inter-group comparison of ISQ Immediately & 6 months post implant placement:

| ISQ results | **Group I (test)** (M±SD) | **Group II** (control) (M±SD) | ***T test value*** | ***P value*** |
|---|---|---|---|---|
| Immediate | 60.57±12.33 | 60.00±9.09 | 0.09 | 0.92 ns |
| Post 6 months | 59.71±6.99 | 58.57±4.65 | 0.36 | 0.72 ns |

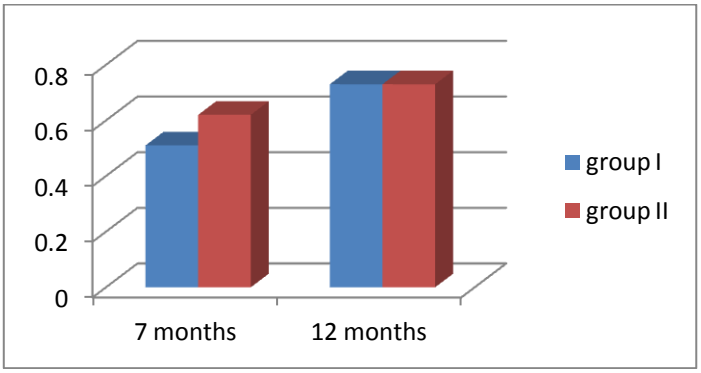



**b)Plaque index(PI) results:**

No valuable difference existed between the two groups regarding the plaque index (PI) in the present study. (PI) increased from (0.63± 0.17) at 7months to (0.73 ±0.22) at 12 months postoperatively in osseodensification group and from (0.62 ±0.08) at 7 months to (0.73± 0.13) at 12 months in the conventional group.

**Table no 3:** Inter-group comparison of mean values of PI at 7& 12 months post implant placement:

| Plaque index results | **Group I (test)** (M±SD) | **Group II** (control) (M±SD) | ***T test value*** | ***P value*** |
|---|---|---|---|---|
| At 7 months | 0.63±0.17 | 0.62±0.08 | 0.16 | 0.87 ns |
| At 12 months | 0.73±0.22 | 0.73±0.13 | 0.08 | 0.93 ns |

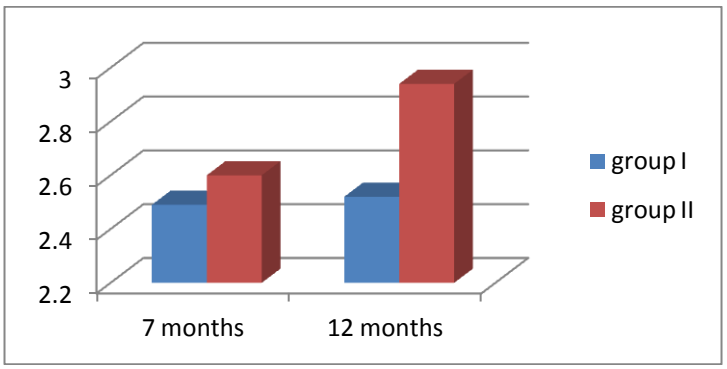



**c) Pocket depth results:**

In monitoring the probing depth of osseodensification group the mean of pocket depths (PD) was (2.49±0.59) & (2.52±0.60) at 7 &12 months respectively while in conventional group was (2.60±0.29) & (2.94±0.34) at 7 &12 months respectively. There was no statistically significant difference between the two groups at the two evaluation periods.

**Table no 4 :** Inter-group comparison of mean values of pocket depth at 7& 12 months post implant placement:

| Pocket depth results | **Group I (test)** (M±SD) | **Group II** (control) (M±SD) | ***t test value*** | ***p value*** |
|---|---|---|---|---|
| At 7 months | 2.49±0.59 | 2.60±0.29 | 0.42 | 0.68 ns |
| At 12 months | 2.52±0.60 | 2.94±0.34 | 1.73 | 0.13 ns |




**B) Radiographic evaluation results:**

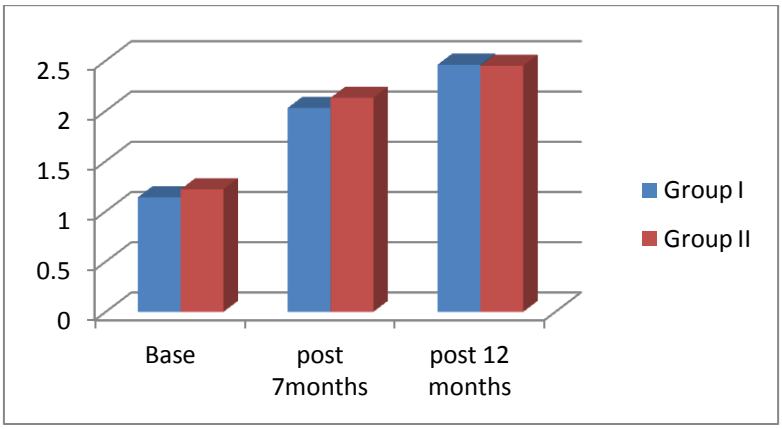
In the current study, cone beam computed tomography (CBCT) was used for radiographic evaluation of implants placed in low density bone (D4) by two different drilling techniques, the osseodensification and the conventional drilling technique. CBCT techniques was taken at base line (48 hours after implant placement), at 7 months & at 12 months following surgery

**1- Marginal bone loss around the implant (MBL) :**

It was interesting to notice that the intragroup comparison of marginal bone loss (MBL) showed statistically significant difference in the osseodensification group when comparing MBL base line and 7 months, also MBL base line and 12 months. However, there was no statistically significant difference between MBL at 7 &12 months. On the other hand, in the conventional group, there was statistically significant difference between MBL values at different evaluation period.

**Table no 5** Inter-group comparison of MBL base ,post 7 &post 12months of implant placement between group I and group II.

| MBL results | **Group I (test)** (M±SD) | **Group II** (control) (M±SD) | ***T test value*** | ***P value*** |
|---|---|---|---|---|
| Base | 1.148±0.35 | 1.22±0.54 | 0.25 | 0.80 ns |
| Post 7 months | 2.03±1.02 | 2.13±0.65 | 0.18 | 0.85 ns |
| Post 12 months | 2.46 ±1.05 | 2.45± 0.60 | 0.014 | 0.98 ns |

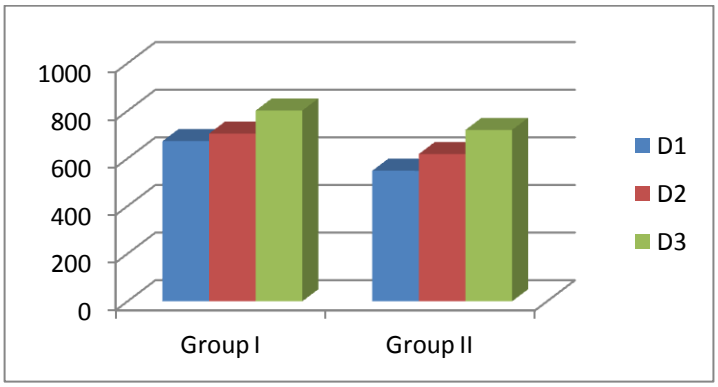



**2- Density of the bone**

Bone density increased at all evaluation periods in both groups in our study. Surprisingly the intragroup comparison results showed statistically significant difference when comparing bone density at 7 months and 12 months in osseodensification group, however in the conventional group statistically significant difference when comparing bone density of base line and 12 months. The inter group comparison of bone density (BD) of group I &group revealed a statistically significant difference at the base line (BD1) in favor of osseodensification group. However, at 7 &12 months (BD2) & (BD3) respectively, there was no statistically significant difference. This was in accordance with the bone density results of Elgrany.

**Table no 6:** Intra-group comparison of D1 ,D2 &D3 in group I and group

| | (M±SD) ***D1*** | (M±SD) ***D2*** | (M±SD) ***D3*** |
|---|---|---|---|
| ***Group I*** | 672.6±97.98 | 704.5±64.88 | 801.4 ±120.3 |
| ***comparison*** | D1versus D2 | D2 versus D3 | D1 versus D3 |
| ***T test value*** | 0.57 | 3.03 | 1.91 |
| ***P value*** | 0.58 ns | 0.022* | 0.10 ns |
| ***Group II*** | 548.3±61.49 | 618.6±176.1 | 719.9± 1.05 |
| ***comparison*** | D1versusD2 | D2months versus D3 | D1 versus D3 |
| ***T test value*** | 1.11 | 1.27 | 4.44 |
| ***P value*** | 0.30 ns | 0.25 ns | 0.004** |




## IV. Discussion

For the implant stability quotient (ISQ) of osseodensification group and conventional group, there was no statistically significant difference between the two groups at base line. This was in accordance with Huwais and Meyer[9] who found no statistically significant differences in implant stability quotient readings between the Osseodensification group and the standard drilling group.

After six months, There was no statistically significant difference between the two groups. By the side of implant stability Sargolzaie et al., [14]stressed about the ideality of the technique and implant system rather than bone quality. Since they compare primary and secondary stability of different bone types using 65 implants (Bio Horizon Implant System) at the three time points (immediately, 1month &3 months after implant insertion) for

each bone density type. Statistical analysis showed no significant difference between ISQ values for each bone types at each follow-up.

On the other hand, Falisi et al., [15] highlighted the importance of the choice of the technique when they compared the effect of different five surgical site preparation techniques (piezo surgery, conventional, under-preparation, bone compaction, bone expansion) on the implant stability in an in vitro study in D4 bone, one implant for each technique.

No valuable difference existed between the two groups regarding the plaque index (PI) in the present study.

By nature, Mahoney et al., [16] stated that plaque may be accumulated along the implant-transmucosal abutment interfaces, transmucosal abutment-prosthesis interfaces, implant-prosthesis interfaces, and on surfaces of the abutment, the implant, and the prosthesis. The size of the microgap between the various components, the degree of surface roughness of the restorations and abutments, the exposure of plasma-sprayed coatings and threaded surfaces of implants, and over contouring of implant restorations contributed to plaque accumulation and provided an ideal environment for bacterial colonization. In our study the PI is good according to salvi and Lang.[17] who measured and scaled it. This may be due to following adequate implant supportive periodontal treatment and good performance of subject's behavioral care.

In monitoring the probing depth, there was no statistically significant difference between the two groups at the two evaluation periods. This was in accordance with Guarineri et al.,[18] who concluded that the changes in the soft tissues including PI, PD, BOP, and recession had no significant differences in either group in the split mouth design study. This could be explained the appraising value of implant maintaince care documentation and pre implant tissue stability.

Multislice computed tomography (CT) has been used as a reliable tool to assess bone quantity and quality. However, the cost and the radiation dose absorbed by the patient during a CT scan are higher than that in other imaging modalities[19]. This limits its application for routine diagnostic workup or periodic examinations[20]

Cone beam CT (CBCT) has been used as a specific tool for head and neck imaging. The advantages of CBCT include high resolution, lower radiation dose, and lower cost compared to CT[21]. CBCT is also a valuable diagnostic tool for preoperative evaluation of implant treatment planning[22]. In addition to the subjective assessment of morphological bone characteristics, it is capable for quantitative measurement of bone at the possible implant site.[23]

With the advent of newer three dimensional imaging CBCT technologies, it became possible to overcome some of the limitations of intra-oral radiographs, to examine the implant and its surrounding tissues in several orthogonal planes and to scroll through the slices to visualize the 3D anatomy[24]so it is advantageous for estimation of bone topography and density for implants.

It was interesting to notice that the intragroup comparison of marginal bone loss (MBL) showed statistically significant difference in the osseodensification group when comparing MBL base line and 7 months, also MBL base line and 12 months. However, there was no statistically significant difference between MBL at 7 &12 months. On the other hand, in the conventional group, there was statistically significant difference between MBL values at different evaluation period.

This may mean that in osseodensification group the marginal bone loss kept maintained after load application however in the conventional group was continuously increased significantly after load. This could be interpreted by the different architecture of the marginal bone which affects the stress distribution around implant this was in agreement with kitamura et al.,[25] who evaluated the influence of marginal bone resorption on the stress around implant in a three dimensional finite element analysis (FEA).

Although there was a relative decrease in bone loss in osseodensification group in comparison to conventional one, the statistical analysis of parametric data showed no statistically significant difference at the estimated t value the two groups at different evaluation periods. This was in accordance with sultana et al., [26] in 2020 that evaluated and compared the loss of crestal bone in 20 implants which were placed in the anterior maxilla by using CBCT. In group I, 10 implants were placed using traditional drilling technique, and in group II, 10 implants placed with OD drilling technique. The implants evaluated at baseline (immediate postoperative), and at 6 months, and 8 months. Crestal bone levels showed no significant difference between the two groups.

Highlighting the correlation between MBL and type of bone in retrospective cross sectional study, Eskandarloo et al.,[27] examined the relation between the marginal bone loss and the bone quality. Of 100 implants, 48 were placed in the maxilla and 52 in the mandible. They found correlation between marginal bone loss and bone quality. Higher bone loss was observed around implants placed in areas of low bone quality. This was augmenting our results.

Bone density increased at all evaluation periods in both groups in our study, this was in accordance with Harby et al.,[28] who evaluated clinically and radiographically the osseointegration, bone level &bone density around short dental implants in posterior atrophic maxilla. 20 short implants were inserted in ten patients

and CBCT was used. The bone density and bone level around implants were measured preoperatively, immediately postoperatively and on interval of 1, 3&6 months. They stated that in the follow up periods the bone density increased and this was due to the compression of the bone produced during implant placement technique. However, they raise a question about the long term prognosis.

Surprisingly the intragroup comparison results showed statistically significant difference when comparing bone density at 7 months and 12 months in osseodensification group, however in the conventional group statistically significant difference when comparing bone density of base line and 12 months. This may mean rapid healing, bone growth and remodeling in osseodensification group than conventional group which was clarified by Trisi et al.,[29] study on sheep. They stated that was probably due to fine boney particle in the walls of the osteotomy and in between the threads of the implant body, which act as new bone growth initiator to enhance progression to secondary stability Furthermore, osteotomy production without extraction of existing bone preserves existing collagen and bone bulk. The presence of collagen and bone bulk enhances revascularization, which is a critical element in new bone growth and remodeling.

The inter group comparison of bone density (BD) of group I &group revealed a statistically significant difference at the base line (BD1) in favor of osseodensification group. However, at 7 &12 months (BD2) & (BD3) respectively, there was no statistically significant difference. This was in accordance with the bone density results of Elgrany. [30]in 2019 who found statistical significant difference in favor of osseodensification group than piezosurgical ridge splitting group but they used standardized periapical radiographic technique. This may raise multiple questions about the results

Amazingly our results were also in accordance with the results of Ruiz et al.,[31] in 2020 who compared the hybrid osseodensification technique (osseodensification by Densah bur + under drilling) and under drilling by drills of the same implant system. Bone density was evaluated by micro CT. They concluded that bone density increased in hybrid osseodensification technique than in the under drilling technique. This may confirm the spectular use of the Densah bur of osseodensification surgical technique in enhancing the bone density.

In no account, an insufficiency in our study sample size in comparison of both techniques could affect the definitive preferences that need future work proposed. The limitation of this work was application of this study on only female gender since the probability for having D4 bone quality is higher than male. This could be farther evaluated in the future planned cohort study.

## V. Conclusion

Based on the limitation of the results of the present study, it was concluded that:-

1) Osseodensification showed enhancement of bone density by the novel Densah bur that work safely in low density bone and decrease the possibility of creating bone dehiscence.

2) CBCT advantageous preoperatively for determining the bone density also postoperatively can adequately measure the bone architecture and density around implants.

3) Based on advantageous present study results, osseodensification technique is reliable method to enhance the rapid healing and maintain the marginal bone integrity after load.

## VI. Recommendation

At the end of this study, limitation of literature about enhancing the primary stability in low density bone (D4) and the osseodensification technique usage in humans. Therefore, the following recommendations can be presented for further researches about our topics:

1. Future comparative studies on different bone density
2. Further studies that involve long-standing follow-up intervals to evaluate the change in architecture and density of bone.
3. Forth coming studies for the evaluation of using the concept of osseodensification by conventional drills.
4. Future Comparative studies to compare osseodensification and the other previous techniques used in low density bone in humans.
5. Future controlled studies will be indicated to test the outcome of immediate post extractive implant with transcrestal sinus lift using osseodensification

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