 DOI:10.21608/adjalexu.2025.344513.1574

EVALUATION OF MAXILLARY SINUS LIFTING AND SIMULTANEOUS IMPLANT PLACEMENT USING BONE DENSIFICATION AND ACTIVATED PLASMA ALBUMIN GEL

Esraa S. Kamal[1]* *BDS*, Ahmed M. Shaaban[2] *PhD*, Lydia N. Melek[3] *PhD*

BSTRACT

BACKGROUND: Implant placement in the maxillary posterior region is challenging due to sinus pneumatization and poor bone quality. Traditional sinus lifts are invasive and carry risks like membrane perforation. A less invasive, safer, and more reliable method for sinus elevation and implant placement is needed for patients with limited bone height.

OBJECTIVES: This study evaluates transcrestal maxillary sinus lifting during implant placement in the posterior maxilla. The technique involves using Densah burs in combination with activated plasma albumin gel to assess clinical and radiographic outcomes.

MATERIALS AND METHODS: Transcrestal sinus lifting was performed using Densah burs and activated plasma albumin gel during implant placement in six patients with 3-5 mm of residual bone height and missing maxillary premolars or molars. Cone Beam Computed Tomography (CBCT) scans were taken before the procedure and after six months to assess outcomes. Bone height and density around the implants were analysed using OnDemand 3D software.

RESULTS: Over six months, there was a significant increase in mean bone height, with an average gain of 5.3 ± 0.70 mm. Bone density around the implants also improved notably, reaching an average value of 255.15 ± 95.69. The sinus membrane remained intact throughout the procedures. Additionally, no statistically significant difference was detected between primary and secondary implant stability.

CONCLUSION: Combining Densah burs and plasma albumin gel in transcrestal sinus lifting is safe and effective, leading to significant bone gain and improve bone density without post-operative complications. Implant stability was consistently maintained, demonstrating the reliability of this technique.

KEYWORDS: Dental implant, Alveolar bone resorption, Tooth extraction, Sinus lifting, Activated plasma albumin gel.

RUNNING TITLE: Sinus Augmentation with Densah Burs and Plasma Gel.

1 MSc student at Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Alexandria University, Alexandria, Egypt
2 Professor at Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Alexandria University, Alexandria, Egypt
3 Professor at Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Alexandria University, Alexandria, Egypt

*** Corresponding Author:**

Email: israa.salem.dent@alexu.edu.eg

INTRODUCTION

Dental implants are widely regarded as the preferred solution for replacing missing teeth, a conclusion supported by numerous clinical studies. However, placing implants in the posterior maxilla presents challenges due to both the poor quality of the bone and the pneumatization of the maxillary sinus, which can occur naturally or following tooth extraction (1,2). As teeth are lost in the posterior upper jaw, the alveolar bone experiences both vertical and horizontal resorption (3). Addressing vertical bone deficiencies may involve ridge augmentation, but for maxillary sinus expansion, sinus floor elevation is necessary to ensure sufficient bone height for implant placement (4). Early sinus lift procedures typically used the lateral window approach, a technique that was invasive and associated with additional morbidity due to the need for autogenous bone grafts. Additionally, the two-step procedure was seen as a significant disadvantage (5).

In 1994, Summer developed a less invasive alternative to the conventional lateral window technique for sinus floor elevation, called the closed sinus lift. This approach uses osteotomes of various sizes to gently elevate the sinus floor. While this method is effective and minimally invasive, it does present certain challenges, such as the potential for heat-induced necrosis due to insufficient irrigation, delayed implant stability, and some patients experiencing complications like headaches or vertigo (6). Primary stability is crucial for the success of implants, and factors such as bone density, particularly the thickness of the cortical bone, play a significant role in achieving stable initial fixation (7).

In 2014, Salah Huwais pioneered the densah bur, a groundbreaking tool that aids in osseodensification, a technique where bone is compacted rather than removed, ultimately enhancing bone health (6). Building on this innovation, in 2018, Huwais and Meyer applied the densah bur to maxillary sinus lift procedures, utilizing its osseodensification

capabilities to raise the sinus floor. The bur's distinctive flute design allows it to work without cutting, using a counterclockwise motion combined with irrigation. This mechanism generates a hydraulic wave at the tip, which gently lifts the sinus membrane. When graft material is added, it also facilitates the membrane's elevation, significantly reducing the risk of perforation (8).

Serum albumin, a protein derived from blood plasma, is widely used in tissue engineering due to its high purity. Recent studies show that osteoblasts can produce albumin, and its concentration increases at bone injury sites. Increasing local albumin levels accelerates bone healing, possibly by attracting stem cells and promoting new bone formation. Additionally, albumin acts as a bacteriostatic barrier, supporting the adhesion and growth of eukaryotic cells (9). Research suggests that adding albumin to the fibrin network alters its ultrastructure, making the fibers thicker and more nodular. This modification could improve the stability and effectiveness of the PRF-based framework, which is fully autologous and biocompatible, offering enhanced durability and a longer period of effectiveness (10). In this approach, an autologous biomaterial is developed by combining a concentrated fibrin matrix with growth factors (CGFs) and denatured serum albumin, aimed at repairing bone defects. This material is known for its enhanced stability and ability to promote bone regeneration (10). This research seeks to assess the impact of combining transcrestal sinus lifting with densah burs and activated plasma albumin gel on improving bone height, implant stability, and peri-implant bone density.

MATERIALS AND METHODS

The study, registered on ClinicalTrials.gov with the identifier #NCT06360263, was approved by the Ethics Committee of the Faculty of Dentistry, Alexandria University. Recruitment took place in the Oral and Maxillofacial Surgery Department at the Faculty of Dentistry, Alexandria University. It involved six participants with insufficient bone height (3–5 mm) beneath the maxillary sinus floor, requiring implants for the replacement of upper posterior teeth (premolars or molars). Following the recommendations of Leonida et al., the sample size was calculated with an 80% power and a 5% alpha error. (11). The average bone gain after surgery was calculated to be 4.37 mm with a standard deviation of 1.45. Using a two-tailed paired test for mean comparison, the minimum required sample size was determined to be four participants. To account for potential dropouts or lost cases, the sample size was increased to six patients. (12). Participants were included in the study if they had missing maxillary premolars or molars, residual bone height between 3 and 5 millimetres, good oral hygiene, and non-smoking habits. Exclusion criteria encompassed poor dental health, systemic medical conditions that could affect the procedure, sinus infections or pathology near the implant sites, multiple sinus septa, and a history of bruxism or clenching. (13,14).

Presurgical assessment

A detailed history was taken, including personal, medical, and dental information, to identify any conditions that might compromise implant success. Panoramic X-rays were initially used to assess whether sinus lifting was required. If indicated, a CBCT scan was performed to provide accurate measurements of residual bone height and width, aiding in the selection of suitable implant dimensions. Intraoral and extraoral examinations were conducted to detect inflammation, and ENT consultations were carried out to rule out sinus-related issues. Patients were fully informed about the risks and benefits of the procedure and gave their consent prior to treatment.

Surgical Technique

The preparation of Activated Plasma Albumin Gel (APAG) involved collecting a minimum of 10 mL of venous blood, which was transferred to a sterile centrifuge tube (White cap Vacuette) and centrifuged at 700 g for 8 minutes using an Eppendorf centrifuge (Germany). After centrifugation, the platelet-poor plasma was extracted with a plastic syringe and heated at 75°C for 10 minutes before cooling to room temperature for 10–15 minutes. The remaining PRF layer, enriched with hematopoietic stem cells (CD34+), was then mixed with the plasma albumin using a three-way stopcock and two plastic syringes with luer locks, resulting in the formation of the Activated Plasma Albumin Gel (11). (Figure 1)

Before surgery, all patients underwent thorough oral scaling and used an antiseptic mouthwash. Local anesthesia was administered via vestibular and palatal infiltration. A crestal incision was made with a No. 15 blade to raise a full-thickness flap, followed by reflection with a periosteal elevator. The implant motor was set to reverse mode (800–1200 RPM), and preparation began with the smallest Densah bur (3.3 mm; Densah Bur Kit, Versah LLC) using a bouncing, in-and-out motion with irrigation to compact the bone.

The first bur progressed to the sinus floor, and subsequent burs penetrated the cortex gently, advancing in 1 mm increments without exceeding 3 mm. The densification process elevated the sinus floor by compacting the bone apically, eliminating the need for grafting. The Valsalva maneuver was performed to ensure the sinus membrane remained intact. After achieving the desired osteotomy diameter, activated plasma albumin gel (APAG) was introduced, and a final bur in counterclockwise motion (150–200 RPM, no irrigation) further propelled the gel to enhance membrane elevation. The implant (Vitronex, Italy) was inserted using a

handpiece initially and finalized manually with a torque wrench. (Figure 2)

The Osstell device (Osstell Inc., W&H Dentalwerk, Salzburg, Austria) was used to measure primary stability. The implant stability quotient (ISQ) obtained from the device indicates the lateral stability of the implant, which depends on the quality of the bone-implant interface and the surrounding bone density (16). (Figure 3)

Postsurgical care

Patients were advised to apply cold packs on their cheeks for the first 12 hours, avoid straws for 10 days, and refrain from sneezing or blowing their nose. Prescribed medications included Amoxicillin clavulanate 1 gm (Augmentin 1 gm, GlaxoSmithKline, UK) twice daily for 5 days, Metronidazole 500 mg (Flagyl, GlaxoSmithKline, UK) three times daily for 5 days, Diclofenac potassium 50 mg (Cataflam, No99vartis-Switzerland) three times daily for 5 days, and the nasal decongestant Xylometazoline (Otrivin, GlaxoSmithKline, UK) 15 ml every 8 hours for 5 days.

Follow-Up and Procedures

Ten days after surgery, the sutures were removed from the implant site. Six months later, the prosthetic phase commenced with the implant being exposed. At this point, secondary stability was evaluated using the Osstell device to record ISQ values. A gingival former was placed for two weeks to establish the emergence profile, followed by obtaining an impression and preparing a cast for fabricating screw-retained restorations. Radiographic changes were assessed six months after the crestal sinus lift procedure using CBCT imaging.

Bone height

Six months after the procedure, bone height was evaluated by measuring the preoperative residual height and comparing it to the distance from the implant platform to the base of the regenerated bone. (Figure 4)

1. clinical trial. Clin Implant Dent Relat Res. 2021;23:317-28.

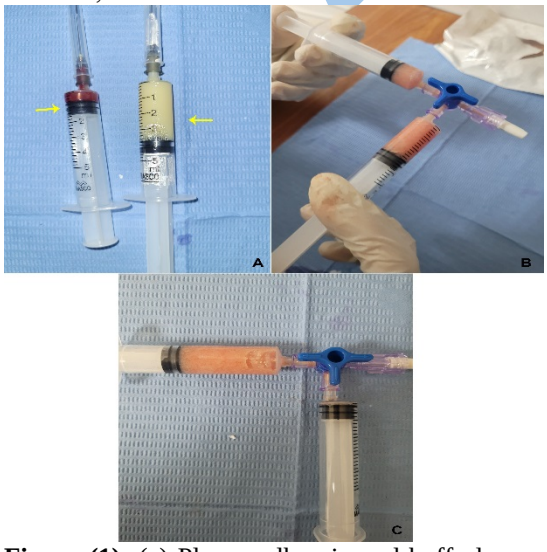

Figure (1): (a) Plasma albumin and buffy layer of PRF (b) Combining the plasma albumin and buffy coat layers using a three-way stopcock (c) Activated plasma albumin gel.

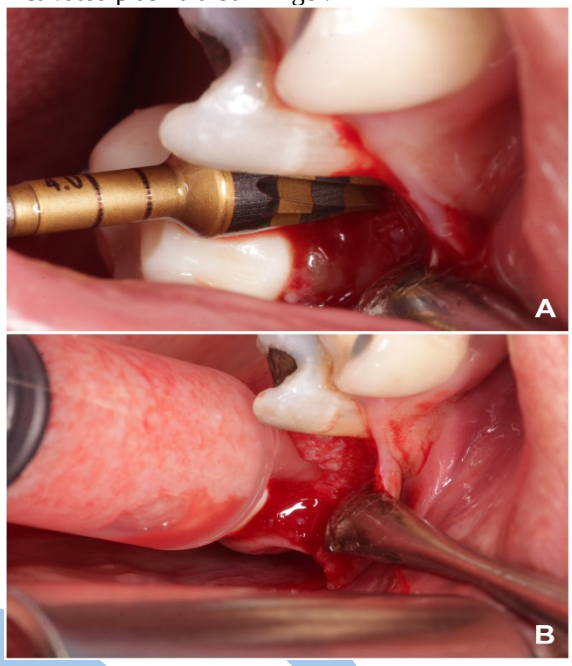

Figure (2): (a) Sinus floor elevation with Densah burs(b) Application of APAG through the osteotome.

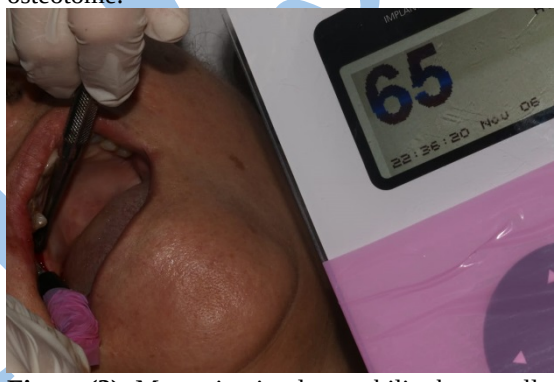

Figure (3): Measuring implant stability by osstell.

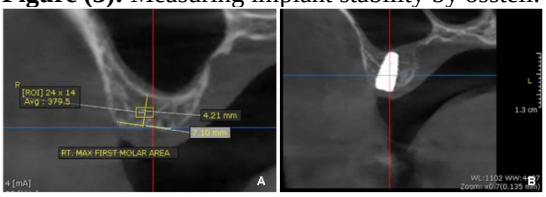

Figure (4): (a) Preoperative cross-section CBCT (b) 6 months post-operative CBCT.

Bone density (HU)

Bone density measurements (HU) were obtained by defining standard rectangular regions on the buccal and palatal aspects of the planned implant site in the preoperative CBCT images. After six months, equivalent rectangular zones were selected, extending from the implant shoulder to its apex along the buccal and palatal walls. A specialized bone density analysis tool within the software was utilized to record these values.

Statistical analysis

Statistical analysis included the calculation of means, standard deviations (SD), medians, interquartile ranges (IQR), and 95% confidence intervals (CI). Normality of the data was tested through descriptive statistics, histograms, Q-Q plots, and the Shapiro-Wilk test. Since the variables were normally distributed, parametric methods were applied. Comparisons were performed using paired samples t-tests, with differences and 95% CI calculated. Analyses were carried out using IBM SPSS software (Version 26.0), and statistical significance was defined as $p < 0.05$.

RESULTS

Six participants were included in the study, with all implants remaining intact and successfully loaded with prosthetic restorations over the six-month follow-up period. No pain or swelling was reported by the patients, and the integrity of the sinus membrane was maintained, confirmed by consistently negative Valsalva tests and radiographic evaluations conducted after the procedure.

Vertical bone gain comparison (mm)

The analysis revealed a significant increase in mean bone gain observed six months post-procedure. (Table 1)

Bone density (Hu)

The study revealed a statistically significant difference in bone density measurements between baseline and the 6-month follow-up. (Table 2)

Implant stability

The analysis revealed no statistically significant difference between primary and secondary stability. (Table 3)

Table (1): bone height measurements

	Mean (SD)	Median (IQR)	95% CI
Baseline	4.42 (0.49)	4.50 (0.78)	3.91, 4.93
After 6 months	9.70 (0.65)	9.87 (1.20)	9.02, 10.38
Bone height gain	5.28 (0.70)	5.29 (1.23)	4.55, 6.02
P value	***P <0.001****		

SD: Standard Deviation, IQR: Interquartile Range, CI: Confidence Interval
*Statistically significant at p-value <0.05

Table (2): Bone density measurements

	Mean (SD)	Median (IQR)	95% CI
Baseline	418.90 (130.11)	421.30 (130.80)	282.36, 555.44
After 6 months	674.05 (111.64)	634.90 (226.67)	556.89, 791.21
Difference	255.15 (95.69)	223.90 (187.32)	154.73, 355.57
P value		***P= 0.001****	

SD: Standard Deviation, IQR: Interquartile Range, CI: Confidence Interval
*Statistically significant at p-value <0.05

Table (3): Implant stability measurements

	Mean (SD)	Median (IQR)	95% CI
Primary bone stability	60.33 (6.74)	58.50 (10.75)	53.26, 67.41
Secondary bone stability	61.50 (8.14)	59.00 (14.25)	52.96, 70.04
Difference	1.17 (4.31)	3.00 (7.25)	-3.36, 5.69
P value	P= 0.54		

SD: Standard Deviation, IQR: Interquartile Range, CI: Confidence Interval
Paired samples t-test was used

DISCUSSION

The effectiveness of sinus lift procedures in rehabilitating the atrophic posterior maxilla is well-documented in the literature. However, the significant post-operative morbidity and risk of complications have prompted researchers to develop less invasive techniques for elevating the maxillary sinus floor. This effort has led to the introduction of the transalveolar approach and the development of increasingly atraumatic methods (18). In 2016, Huwais and Meyer introduced the use of densah burs in sinus lifting, providing a safer and less complicated alternative. These burs are specifically designed to atraumatically and precisely prepare the osteotomy site while simultaneously condensing the bone, offering a controlled method for sinus floor elevation (8).

This study evaluates the combined effect of densah burs and activated plasma albumin gel in transcrestal maxillary sinus lifting for patients with limited alveolar bone height (3-5 mm). The study included six patients aged 37 to 58 years, with six implants placed, each measuring 8 mm in length, similar to the methodology of Nedir et al. (19). All implants were successful, with no reported failures according to established implant success criteria (20).

The average bone height gain achieved was 5.28 ± 0.7 mm, exceeding the results reported by Huwais et al. (8) and Elghobashy et al. (21,22). The use of activated plasma albumin gel facilitated membrane elevation and stabilization beyond the level attainable with densah burs alone, resulting in bone height gain extending beyond the implant apex. This innovative application underscores the gel's role in enhancing the efficacy of sinus membrane elevation.

Post-operative complications, such as graft failure and infection—often linked to Schneiderian membrane perforations—are a major concern as they can compromise implant survival rates (23). In this study, no membrane perforations were reported. The combined use of densah burs and activated

plasma albumin gel proved effective in protecting the sinus membrane, creating a favorable healing environment that minimized complications, including membrane perforation, infection, and graft failure (11).

Bone density around the implant, a critical factor for successful osseointegration in the often less-dense maxillary bone, showed a significant increase. This aligns with findings by Huwais and Meyer (6), Elghobashy et al. (21,22), and Vinay Kumar et al. (24). The densifying effect of densah burs compacted the bone during osteotomy, while the plasma albumin gel acted as a bioactive scaffold to promote bone regeneration, together enhancing the local bone environment.

Implant stability showed no significant difference between immediate placement and six months post-operatively, indicating that the initial stability achieved during placement was well-maintained over time. This result is attributed to improved bone density and a favorable healing environment, consistent with the findings of Hinidi and Salwan (25) and Bergamo et al. (26).

CONCLUSION

The combination of transalveolar sinus lift using densah burs and activated plasma albumin gel, alongside simultaneous implant placement, represents a significant advancement in dental implantology. This approach provides a less invasive, safer, and more effective alternative to traditional methods, particularly for patients with compromised bone conditions and limited bone height. As ongoing research validates its benefits, it shows great potential for broader implementation in clinical.

Conflict of interest

The authors declare that they have no conflict of interests.

Funding statement

For this work, the authors didn't receive any specific funding.

REFERENCES

2. Kim B, Lee J. The Retrospective Study of Survival Rate of Implants with Maxillary Sinus Floor Elevation. J. Korean Assoc. Oral Maxillofac. Surg. 2010, 36, 108.
3. Cawood JI, Howell RA. A classification of the edentulous jaws. Int J Oral Maxillofac Surg. 1988;17:232-6.
4. Morand M, Irinakis T. The Challenge of Implant Therapy in the Posterior Maxilla: Providing a Rationale for the Use of Short Implants. J. Oral Implant. 2007, 33, 257–266.
5. Wallace S, Froum S. Effect of Maxillary Sinus Augmentation on the Survival of Endosseous Dental Implants. A Systematic Review. Ann. Periodontol. 2003, 8, 328–343.
6. Huwais S, Meyer EG. A novel osseous densification approach in implant osteotomy preparation to increase biomechanical primary stability, bone mineral density, and bone-to-implant contact. Int J Oral Maxillofac Implants. 2017;32:27-36.
7. Sánchez-Siles M, Ilha JB, Ruizc JA, Alonsod FC, Alonso FC. Evaluation of primary stability and early healing of 2 implant macro designs placed in the posterior maxilla: a split-mouth prospective randomized controlled clinical study. J Oral Rehabil. 2019;5:8-15.
8. Huwais S, Mazor Z, Ioannou AL, Gluckman H, Neiva R. A multicenter retrospective clinical study with up-to-5-year follow-up utilizing a method that enhances bone density and allows for transcrestal sinus augmentation through compaction grafting. Int J Oral Maxillofac Implants. 2018;33:1305-11.
9. Horváthy DB, Simon M, Schwarz CM, Masteling M, Vácz G, Hornyák I, et al. Serum albumin as a local therapeutic agent in cell therapy and tissue engineering. Biofactors. 2017;43:315-30.
10. van Gelder JM, Nair CH, Dhall DP. Colloid determination of fibrin network permeability. Blood Coagul Fibrinolysis. 1996;7:747-60.
11. Leonida A, Caccianiga P, Bader AA, Rosi S, Ceraulo S, Caccianiga G. Activated plasma albumin gel (APAG) in transalveolar technique for maxillary sinus lift: A case series. Inventions. 2022;7:99.
12. Petrie A, Sabin C. Medical statistics at a glance. 3rd ed. West Sussex, UK: John Wiley & Sons, 2009.
13. Arafat SW, A Elbaz M. Clinical and radiographic evaluation of osseodensification versus osteotome for sinus floor elevation in partially atrophic maxilla: A prospective long term study. Egypt Dent J. 2019;65:189-95.
14. López-Quiles J, Melero-Alarcón C, Cano-Duran JA, Sánchez-Martínez-Sauceda EI, Ortega R. Maxillary sinus balloon lifting and deferred implantation of 50 osseointegrated implants: a prospective, observational, non-controlled study. Int J Oral Maxillofac Surg. 2018;47:1343-9.
15. Porth CJ, Bamrah VS, Tristani FE, Smith JJ. The Valsalva maneuver: mechanisms and clinical implications. Heart Lung. 1984;13:507-18.
16. Sennerby L, Meredith N. Implant stability measurements using resonance frequency analysis: biological and biomechanical aspects and clinical implications. Periodontol 2000. 2008;47:51-66.
17. Good M, Stiller C, Zauszniewski JA, Anderson GC, Stanton-Hicks M, Grass JA. Sensation and Distress of Pain Scales: reliability, validity, and sensitivity. J Nurs Meas. 2001;9:219-38.

18. Lafzi A, Atarbashi-Moghadam F, Amid R, Sijanivandi S. Different techniques in transalveolar maxillary sinus elevation: A literature review. J Adv Periodontol Implant Dent. 2021;13:35-42.
19. Nedir R, Nurdin N, Khoury P, Bischof M. Short implants placed with or without grafting in atrophic sinuses: the 3-year results of a prospective randomized controlled study. Clin Implant Dent Relat Res. 2016;18:10-8.
20. Papaspyridakos P, Chen CJ, Singh M, Weber HP, Gallucci GO. Success criteria in implant dentistry: a systematic review. J Dent Res. 2012;91:242-8.
21. Elghobashy MTM, Shaaban AM, Melek LNF. Radiographic comparison between Densah burs and osteotome for graftless internal sinus lifting with simultaneous implant placement: a randomized clinical trial. Int J Oral Maxillofac Surg. 2023;52:388-95.
22. EL-Ghobashy MT, Shaaban AM, Melek LN. Osseodensification by densah burs versus osteotome for transcrestal maxillary sinus lifting with simultaneous implant placement. Alex Dent J. 2023;48:51-8.
23. Nolan PJ, Freeman K, Kraut RA. Correlation between Schneiderian membrane perforation and sinus lift graft outcome: a retrospective evaluation of 359 augmented sinus. J Oral Maxillofac Surg. 2014;72:47-52.
24. Kumar MV, Gupta U, Bhavani M, Kathuria B, Mandale A, Gattu A. The effect of osseodensification technique on implant stability: Clinical study. Ann Rom Soc Cell Biol. 2020;24:1069-80.
25. Hindi AR, Bede SY. The effect of osseodensification on implant stability and bone density: A prospective observational study. J Clin Exp Dent 2020;12:e474-e8.
26. Bergamo ETP, Zahoui A, Barrera RB, Huwais S, Coelho PG, Karateew ED, et al. Osseodensification effect on implants primary and secondary stability: Multicenter controlled