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EVALUATION OF THE USE OF TITANIUM PLATELET RICH FIBRIN IN SINUS FLOOR ELEVATION THROUGH FLAPLESS TRANSCRESTAL APPROACH (A RANDOMIZED CONTROLLED CLINICAL STUDY)

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ABSTRACT

INTRODUCTION: Dental implant therapy in the posterior maxilla may be difficult owing to limited bone height after dental extraction with sinus pneumatization. Several approaches for sinus floor elevation have been documented, and hence flapless transcrestal sinus floor elevation is minimally invasive technique which is used in moderately defected maxilla.

OBJECTIVES: Evaluate both clinical and radiographic outcomes in sinus floor elevation in transcrestal sinus lift approach with Titanium platelet rich fibrin (T-PRF) as a sole sinus graft material compared to Platelet rich fibrin (PRF).

MATERIALS AND METHODS: This study was designed as randomized controlled clinical trial conducted between March 15, 2022 and February 5, 2023. 16 patients were randomly allocated into two groups: in the study group 8 patients underwent flapless transcrestal sinus lift with simultaneous implant placement using T-PRF as a grafting material, while in the control group 8 patients had PRF as a grafting material.

Clinical outcomes including assessment of patient's post-operative pain, swelling, primary and secondary implant stability were recorded on different time points. Radiographical assessment was conducted using Cone beam computed tomography (CBCT) to measure residual bone height (RBH), bone density, and sinus bone gain (SBG).

RESULTS: No significant difference found regarding postoperative pain, edema, and nasal bleeding. The mean of primary implant stability in study group was 58.63±5.68 while in the control group was 54.5±6.41. No correlation between SBG and the use of T-PRF (P value = 0.389).

CONCLUSION: No significant difference was found between PRF and T-PRF in clinical and radiographical evaluation, both PRF and T-PRF showed good outcomes. More studies are recommended to investigate this topic.

KEYWORDS: T-PRF, PRF, Transcrestal sinus lifting, Implant.

RUNNING TITLE: T-PRF versus PRF for transcrestal sinus lifting.

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INTRODUCTION

With the increase of using dental implants as a prosthetic option, it became clear that the posterior maxillary area was generally limited for routine implant placement (1). In fact, following dental extraction, the alveolar bone undergoes remodeling, resulting in the reduction of remaining bone volume horizontally and vertically, furthermore, crestal bone loss that occurs in the posterior maxilla could be accompanied by maxillary sinus pneumatization, which may lead to a further reduction in the sufficient available bone volume for implant insertion (2). In such cases for ideal implant placement and satisfactory results, a great number of edentulous patients in the posterior maxilla may require bone augmentation and sinus lifting procedures, resulting in an acceptable bone height that is suitable for dental implant placement (3). Tatum performed the first lateral window surgery in

1975 for sinus lifting (4). However, the associated morbidity, long healing period for ossification of the grafted biomaterials, and the need for a second surgery for implant placement are all drawbacks of Tatum's approach (5). Summers suggested a procedure in 1994 that allowed sinus floor elevation through a crestal approach, simultaneously with implant insertion, utilizing a tool called an osteotome. The key benefit of the crestal sinus lift approach is that it is a less invasive procedure, shorter surgical time, and lesser complications, it enhances the maxillary bone's density, which enables implants to have higher initial stability (6). However, one of the drawbacks of this procedure is that only 3 to 4 mm an average increase in bone height could be gained through this approach and in which a minimum of 5 to 6 mm of bone height should be available to obtain sufficient primary implant stability (7). Various sinus augmentation materials including autogenous bone and/or bone substitute have been documented to allow the correct placement of implants in the case of the severely resorbed posterior maxilla (8). In several clinical investigations and reports, the maxillary sinus augmentation could be operated with multiple bone grafting materials, including autogenous bone grafts harvested from the iliac crest or intraoral sites or other sites in addition to bone substitutes (9). Due to its distinct osteogenic, osteoconductive, and osteoinductive qualities, autogenous bone has a long history of clinical effectiveness in sinus augmentation (10). However, high patient morbidity rates and the limited volume of harvested bone are all significant reasons for clinicians to adopt xenografts and bone substitutes instead of autogenous
grafts (11), where the cost and long healing time were the major drawbacks (12). Recently, there has been an increase in platelet-rich products used for the completion of multiple dental procedures. Platelet concentrates were first used in transfusion medicine to treat and prevent haemorrhage caused by severe thrombopenia where Platelet-rich plasma (PRP) is the term used to refer to the standard platelet concentrate used for transfusion (13). One of the recent developments in platelet concentrates is Choukroun's PRF which is composed of a leucocyte and platelet rich fibrin (L-PRF) in addition to Active PRF (A-PRF). For the production of the PRF products, blood is drawn without using anticoagulant agents, followed by immediate centrifugation where the coagulation process will occur spontaneously which facilitates the collection of the formed clot. However, (L-PRF) and (A-PRF) are different in the time and speed of centrifugation required to obtain these two PRF products (13, 14). Platelets and leukocytes besides other growth factors, such as transforming growth factor-beta1 (TGF- β1) and platelet-derived growth factor (PDGF), in addition to vascular endothelial growth factor (VEGF), interleukin (IL)-1, IL-4, and IL-6, are present in this fibrin matrix (15). The osteoblasts, endothelial cells, chondrocytes, and different types of fibroblasts will go under proliferation and differentiation directly promoted by these growth factors (16). Positive clinical outcomes have been observed by using PRF where in 2012, Mazor et al. employed PRF as a single grafting material in sinus lifting procedure (17). Traditional blood collection tubes made of Glass-evacuated with silica activators have raised safety concerns among some doctors. O'Connell explained of the unavoidable silica contact. Despite being dense enough to settle with the red blood cells, the small size of the silica particles will allow it to be colloidally suspended not only in the buffy coat, but also within fibrin, and platelet-poor plasma layers. As a result, the contaminated blood products with these particles may reach the patient when used for treatment (18). Recently, a new product called T-PRF was developed, based on the possibility that titanium may activate platelets more effectively than the silica activators employed with glass tubes used in the method of Chouckroun's leukocyte and platelet-rich fibrin (L-PRF) (19).

More studies are needed to evaluate the clinical and radiographical outcomes in using TPRF in transcrestal sinus lifting approach in comparison with the conventional PRF. The recently introduced T-PRF is based on the hypothesis that Titanium tubes maybe safer and more efficient in activating platelets in comparison with the glass tubes used in the production of Chouckroun's PRF, so a more stable clot with highly condensed fibrin mesh could be obtained. This study aimed to evaluate both the clinical and radiographical outcomes of using T-PRF in flapless transcrestal sinus lifting approach.

MATERIALS AND METHODS

This study was designed as a randomized controlled clinical trial and approved by the Ethics Committee, at the Faculty of Dentistry, in Alexandria University. The trial was registered in clinical trials.gov under the registration ID number NCT05721612. The study included 16 patients who required implant placement for their missing posterior maxillary teeth (premolars and molars) who had insufficient bone height under the maxillary sinus. The subjects were allocated into 2 groups, and each group received 8implants. The study was performed in the Oral and Maxillofacial Surgery Department, at Faculty of Dentistry, Alexandria University.

Inclusion criteria (20) for patient selection were: patient seeking replacement of a missed maxillary posterior teeth with a residual bone height of 5-7 mm, age from 25 to 60, and good oral hygiene. The exclusion criteria (20) were: patients with uncontrolled diabetes, coagulation disorders, immunological disorders, previous radiation of the head and neck area, alcohol or drugs abuse, therapy

with Bisphosphonates, ongoing chemotherapy and Heavy smokers (21).

Preoperative assessment

Full personal history including patient's name, age, profession, address, contact info of the patient and of a close relative was taken. Moreover, previous medical and dental history were taken to exclude any medical condition that may affect the success of the implant. Also, data regarding the etiology of tooth/teeth extraction was collected. Clinical examination was performed intraorally and extraorally using inspection and palpation to exclude any abnormality, infection or inflammation.

Laboratory investigation was done to every patient to exclude any bleeding or coagulation disorders by doing Complete Blood Count (CBC), bleeding time test, International Normalized Ratio (INR) together with Partial Thromboplastin Time (PTT).

Preoperative measurement of residual bone height (RBH) in addition to measurement of buccolingual bone width was done to choose the appropriate implant size. **(Figure 1.A)**

To protect patients' welfare and safety, all participants were informed about the procedure's benefits and risks before beginning, and they all signed an informed consent form.

Surgical technique

One hour before surgery, patients were asked to have 2.0 g amoxicillin with clavulanic acid or 600 mg clindamycin if they had a history of Penicillin allergy and for rinsing of the mouth with a 0.2% chlorhexidine mouthwash for 2 minutes before the surgery.

All patients included in the study were treated under local anesthesia by vestibular and palatal infiltration, using 4 % Articaine hydrochloride and epinephrine (1/100000). For the preparation of the platelet concentrate, 10 ml of patient's blood were obtained from antecubital vein by a qualified nurse. Collected blood was immediately transferred to Titanium tube and centrifuged in centrifugation device (Centrifuge 80-1 , China) at 2800 rpm for 12 min for the study group to obtain T-PRF while the collected blood of the control group was immediately transferred to disposable glass tube that was centrifuged at 3000 rpm for 10 min to obtain PRF (22). **(Figure 1.B)**

For proper implant positioning in mesiodistal available space, custom made clear acrylic surgical guide with a perforation on the site of the implant position was placed in site then a 2mm round bur was introduced through the perforation to make a mark on the tissue **(Figure 1.C)**. After that tissue punch was used around the mark to excise the soft tissue covering the osteotomy site.

Osteotomy site preparation begun by drilling of 2.0mm twist pilot drill to the depth of 1.5 mm away and inferior to the sinus membrane **(Figure 1.D)**, followed by using 2.7mm intermediate drill to same depth used with the pilot drill. After that, the first instrument to be inserted in the prepared osteotomy site was osteotome of 3.2 mm (Dentium, Korea) using wedging motion, and by pushing the osteotome apically through in and out motion with 1 mm increment until the desired sinus floor elevation was obtained **(Figure 2.A)**.

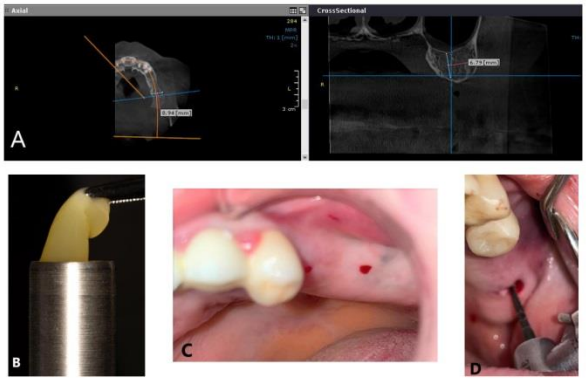

Figure (1): A) Measurment of RBH and buucolingual width. **B)** T-PRF. **C)** Drilling marks on the tissue. **D)** 2mm twist drill for osteotomy preparation.

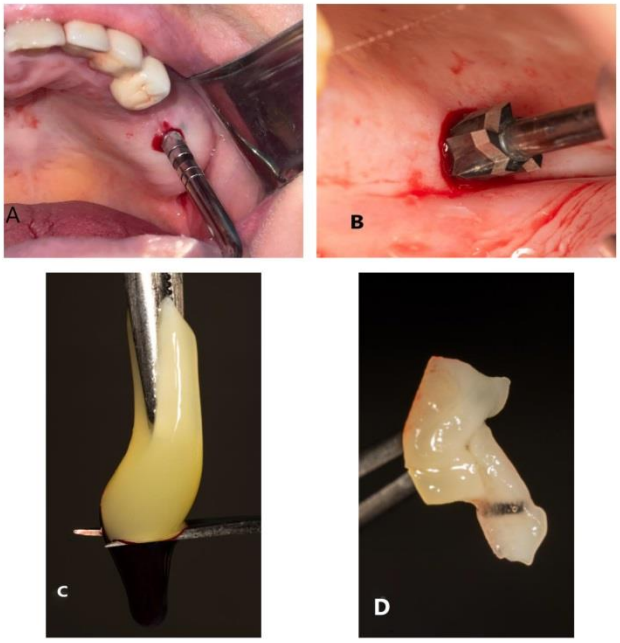

Figure (2): A) Osteotome used for sinus lifting. **B)** Countersink drill preparation. **C)** Clot separation from basal layer. **D)** Dividing the clot obtained into smaller pieces.

Further enlarging of the osteotomy site was done by using the second osteotome with a diameter of 3.8mm that was inserted with gentle pressure in the same motion previously used until the same required level of sinus floor elevation was gained. A third osteotome was inserted using the same technique if it was

desired to more enlarge the osteotomy site to place a wider implant diameter.

Countersink drill that is used for crestal bone preparation was used after last osteotome to ensure passive fit of the implant neck into the surgical site **(Figure 2.B)**. The following step was to check the integrity of the sinus membrane and to make sure there were no signs of sinus perforation by using a depth gauge or by injecting of normal saline into the osteotomy site, if all the saline came back from the surgical site and no saline was running from the nose, then the sinus membrane integrity is expected. All the surgical drills and osteotomes used for site preparation were from Dentium surgical kits (Dentium, Korea).

Each clot was removed from the tube and separated by scissors from the basal layer of red blood cells (**Figure 2.C)** and further dividing of the obtained clot was done to enable easily packing of the fibrin clot inside the osteotomy site incrementally using the last osteotome used **(Figure 2.D)**. Increments of the fibrin clot were added and packed successively using the same osteotome. T-PRF was packed in the surgical site of the study group while the PRF was packed in the control cases **(Figure 3.A)**.

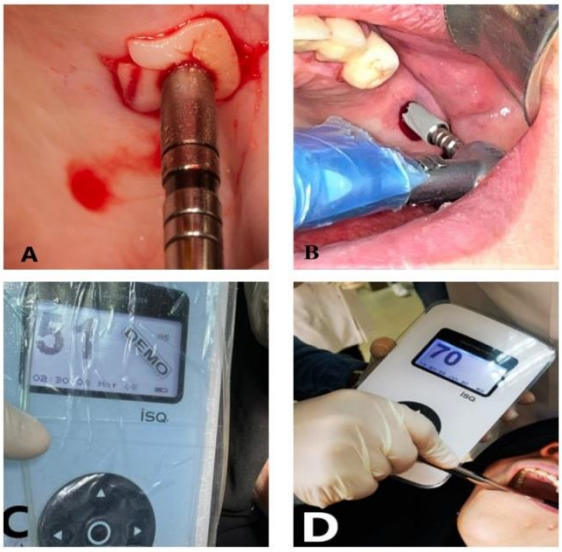

Figure (3): A) Packing of clot inside osteotomy. **B)** Implant placement. **C)** Primary implant stability measurement. **D)** Secondary implant stability measurement.

Implant placement (Dentium, Korea) that was larger than the site prepared by the last osteotome to ensure primary implant stability was done (**Figure 3.B**). After implant placement and by using Resonance Frequency Analysis (RFA) using Osstell® device (Osstell AB, Sweden), smart peg was tightened manually over the fixture and measurement of primary implant stability was recorded **(Figure 3.C)**.

Finally, healing abutments were placed in cases where the insertion torque was greater than 30 Ncm while cover screws were placed in cases when the insertion torque was less than 30 Ncm (23). In this context, one meta-analysis conducted by Esposito et al. (24) mentioned that there is no significant difference regarding the use of healing abutments or cover screws in implant success.

Postoperative care

Patients were asked to follow postoperative instructions by applying cold packs over the cheeks for 10 minutes each hour for the first 12 hours after the procedure to reduce swelling and discomfort. In addition to avoid any actions that might create high pressure or vacuum effect inside the sinus, like sneezing, nose blowing or drinking with straws for 10 days.

The following therapeutic agents were prescribed: Amoxicillin with clavulanic acid 1 tablet every 12 hours daily for 5 days (Augmentin 1g (875 mg amoxicillin + clavulanic acid 125) GlaxoSmithKline, UK.), Ketoprofen 150mg 1 tablet every 12 hours daily for 3 days (Bioprofenid, Sanofi, Egypt), nasal decongestant: Otrivin one drop in each nostril every 8 hours for 5 days (Novartis Pharma AG, Basle, Switzerland), and mouth wash (Chlorhexidine 0.2%) 4 times a day for 2 weeks (Orovex mouth wash, Macro group, Egypt).

Clinical follow up

Pain was measured using the visual analogue scale (25), data reported from the patient were numbers ranged from 0 to 10 with value of:

- 0 value stands for no pain that was recoded.
- 2 to 4 value – is considered as mild pain.
- 5 to 7 value – is considered as moderate pain.
- 8 to 10 value – is considered as severe pain.

The surgeon's finger was pressed on a specific area of the patient's cheek for 5 seconds to quantify postoperative oedema. The oedema is graded on a scale from 0 to 4 (26) as follows:

- Grade 0 with no edema that was noticed.
- Grade 1: a (2 mm) slight pitting that recovers right away and is not visibly distorted.
- Grade 2: a (4 mm) mild pitting that returns in less than 15 seconds and with no distortion.
- Grade 3: a (6 mm) moderate pitting, takes up to 30 seconds to rebound with clear distortion.
- Grade 4: a (8 mm) severe pitting, takes up more than 30 seconds to rebound with clear severe distortion.

Postoperative pain, oedema, and presence of nasal bleeding were measured on 1st, 3rd, and 7th day.

To check for osseointegration, measurement of the mean primary implant stability was done from three different sites, occlusal, buccal and palatal side of the smart pig using Osstell® at time when the implant was placed as well as after 6 months **(Figure 3.D)**.

Immediate postoperative CBCT (T1) was done to measure the implant protrusion length (IPL) which was the distance protruded by the implant into the maxillary sinus measured in cross section view at the center of the implant long axis (**Figure 4.A)**.

Gray scale was used to measure bone density around implant apex on cross section of (T1) CBCT because it is well known that gray scale strongly correlates to Hounsfield Units (HU) obtained from CT (27).

Two points, one buccal and one palatal to the implant in cross section view, at the level of implant apex that are 1 mm apart from the implant outer surface were selected and software automatically gave the average density at the selected points and the average of the two readings was taken. Six months postoperatively CBCT (T2) was done to measure amount of SBG which equals implant protrusion length (IPL) added to Peri-implant sinus bone level (PSBL) which is the distance between implant apex and the new sinus floor bone level **(Figure 4.B)**.

Gray scale was used to measure bone density around implant apex on cross section of (T2) CBCT. The same two points that were selected on (T1) were selected and average bone density was calculated. Cuts of CBCT (cross sectional), for measuring IPL, SBG and bone density, were analyzed using OnDemand 3D™ software.

After 6 months, patients were recalled to impression making visit for permeant crowns. Healing abutments were removed and impression was done using additional silicon. Try in using polymethyl methacrylate (PMMA) was done to verify the accuracy of the final restoration. In the last visit, abutments were placed over the implants and torqued to 30Ncm, and digitally designed zirconium crowns were delivered (**Figure 4.C, D**).

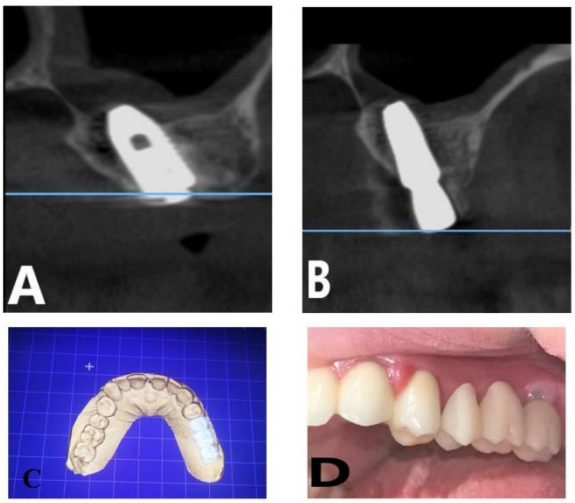

Figure (4): X-ray done immediate post operative. **B)** X-ray 6 months follow up. **C)** Digitally designed crowns. **D)** Final crowns delivery.

Edema and nasal bleeding

Statistical analysis

Normality of quantitative variables was checked using Shapiro Wilk test and Q-Q plots. Age, implant stability, and bone density were normally distributed while pain scores were non normally distributed. All quantitative variables were presented using mean, median, standard deviation in addition to minimum and maximum values while qualitative data (gender, pain categories, and edema) were presented using frequency and percent. Percent change in implant stability and bone density was calculated using the following formula: [(Follow up values – baseline values) / baseline values] x 100.

Comparison between groups regarding age, implant stability, and bone density were done using independent t test while Mann Whitney U test was performed to assess differences in pain scores and between groups. Chi Square test was performed to analyze gender and edema levels between groups. Friedman test followed by post hoc test was applied to assess differences in pain scores between time points while paired t test was used to analyze differences in implant stability and bone density within each group. All tests were two tailed and significance level was set at p value≤0.05. Data were analyzed using IBM SPSS, version 23, Armonk, NY, USA.

RESULTS

Demographic data

Sixteen participants were enrolled in this study, 8 patients for each group. In the T-PRF group there were 5 female patients and 3 male patients, while in P-RF group only 2 male patients were enrolled. Patients age range was from 33 to 58 years with mean of 44.25±9.41 in the T-PRF group, while in PRF group the age participants were between 39 and 57 years and mean 45.88±5.69. No statistically significant difference was found between the 2 groups in terms of gender or age.

Clinical Evaluation Data

Pain Scores

There was no significant difference in pain scores between the two study groups on the first, third, and seventh days, while within the same group there was a significant difference a cross three time points within the T-PRF group (*P* value = 0.001), the significance was found between day 1 and day 7 (P_2 value= 0.005). Moreover, within the PRF group a significant difference was reported between the three time points (*P* value= 0.007), the difference was detected between day 1 and day 7 (P_2 value= 0.026). **(Table 1)**

Regarding edema and nasal bleeding, no significant difference was noted neither in the T-PRF nor the PRF group.

Implant stability

The implant stability was measured twice during this study, primary implant stability measured immediately after the implant placement, and the secondary implant stability was measured after six months. The mean of primary implant stability in T-PRF group was 58.63±5.68 and 54.50±6.41 in the PRF group. The secondary implant stability mean was 73.50±3.51 in the T-PRF group, while it was 72.63±2.67 in the PRF group. The percentage of increase in implant stability was calculated for test and control groups and it was not significantly correlated to the type of grafting material used **(Table 2)**.

Radiographical Evaluation Data

Implant Protrusion Length

There was no significant difference in terms of implant protrusion length between the two groups even though the mean of implant protrusion length was slightly higher in T-PRF (2.44±0.58mm) in comparison to PRF mean (2.13±0.63mm).

Residual bone Height and sinus Bone Gain

The mean of residual bone height was 6.06±0.66mm and 6.13±0.59 mm in T-PRF and PRF groups respectively, while the SBG mean was slightly higher in T-PRF subjects (2.51±0.55mm) than the mean of SBG in PRF subjects (2.26±0.57mm). No significant difference was recorded in the two variables (residual bone height and SBG) in both groups.

Bone Density

In the T-PRF group the mean of immediate bone density was 357.40±46.29, and increased to 1004.03±19.29 after six months. In the PRF group the bone density mean was 342.31±43.51 and increased to 985.43±34.90 after six months **(Table 3, Figure 5)**. Even though the postoperative bone density was higher in the T-PRF group, no significant difference was found between the T-PRF and the PRF groups in terms of bone density, neither immediately nor after six months.

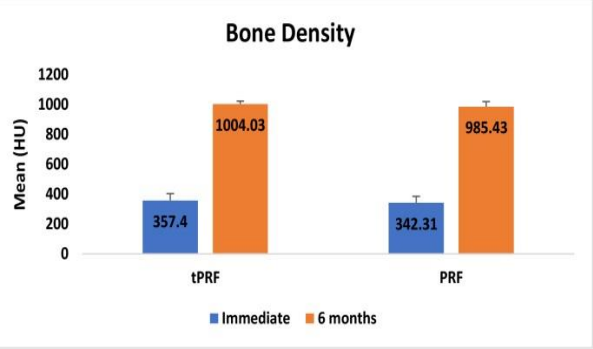

Figure (5): Bone density mean.

Change within the two groups there was a significant difference between the bone density in the two time points: immediately and after six months (p value <0.0001 for T-PRF and PRF group).

Table 1: Comparison of pain scores between T-PRF and PRF groups at different time points

		T-PRF group (n=8)	PRF group (n=8)	*P* value
1st day	Mean ± SD	3.88 ± 2.36	2.38 ± 1.41	0.176
	Median	4.50	2.00	
	Min - Max	0.00 – 7.00	0.00 – 5.00	
3rd day	Mean ± SD	1.25 ± 1.49	1.75 ± 1.28	0.418
	Median	1.00	2.00	
	Min - Max	0.00 – 4.00	0.00 – 4.00	
7th day	Mean ± SD	0.25 ± 0.71	0.00 ± 0.00	0.317
	Median	0.00	0.00	
	Min - Max	0.00 – 2.00	0.00 – 0.00	
***P* value**		0.001*	0.007*	
Pairwise comparison		P_1=0.101, **P_2=0.005*,** P_3= 0.951	P_1=1.00, **P_2=0.026*,** P_3= 0.073	

*Statistically significant difference at *p* value≤0.05. P_1: comparison between 1st day and 3rd day, P_2: comparison between 1st day and 7th day, P_3: comparison between 3rd day and 7th day

Table 2: Comparison of primary and secondary implant stability (ISQ) between T-PRF and PRF groups at different time points

		T-PRF group (n=8)	PRF group (n=8)	*P* value
Primary	Mean ± SD	58.63 ± 5.68	54.50 ± 6.41	0.195
	Median	59.50	54.50	
	Min - Max	49.00 – 68.00	44.00 – 62.00	
Secondary	Mean ± SD	73.50 ± 3.51	72.63 ± 2.67	0.583
	Median	72.50	72.50	
	Min - Max	70.00 – 79.00	69.00 – 77.00	
***P* value**		**<0.0001***	**<0.0001***	

*Statistically significant difference at *p* value≤0.05.

Table 3: Comparison of bone density between T-PRF and PRF groups

		T-PRF group (n=8)	PRF group (n=8)	*P* value
Immediate	Mean ± SD	357.40 ± 46.29	342.31 ± 43.51	0.513
	Median	372.80	330.80	
	Min - Max	283.90 – 401.60	294.50 – 411.90	
6 months	Mean ± SD	1004.03 ± 19.29	985.43 ± 34.90	0.208
	Median	1004.75	1001.65	
	Min - Max	973.40 – 1029.60	933.00 – 1021.60	
***P* value**		**<0.0001***	**<0.0001***	

*Statistically significant difference at *p* value≤0.05.

DISCUSSION

Over the years, sinus lifting techniques have evolved, starting with lateral approach by Tatum (4) and moving on to transcrestal approach by Summers who was the first to utilize a tool called osteotome (6). Different grafting material have been utilized for augmentation under the elevated sinus floor, including autogenous bone and/or bone substitute in order to allow proper placement of implants in the case of severely resorbed posterior maxilla (8).

This study was conducted to evaluate the use of T-PRF as a sole grafting material in sinus floor elevation through flapless transcrestal approach using osteotomes.

Sixteen patients were divided into 2 categories. The ages of the participants ranged between 33 and 58 years with mean age for the T-PRF group of 44.25 ±9.41 years, while in PRF group the mean of the age was 45.88 ± 5.69 years.

Sixteen implants were inserted with diameter ranged from 3.6 mm to 5 mm, the implant length was chosen to be compatible with the residual bone height at the implant placement site, in cases with 5 to 6 mm implants with 8 mm length were selected, and in cases with 7 mm residual bone height, 10 mm implants were selected.

According to the standards followed for implant success assessment, none of the implants that was placed in the two groups failed (28).

Pain, edema and nasal bleeding were assessed postoperatively at day one, three, and seven. No significant difference was recorded between the two groups regarding pain scores at any of the measurement times, while there was a significant correlation between the timepoints and the recorded pain scores within the same group, the significance was recorded between day one and day seven, most of the patients reported mild pain at the first day (mean = 3.88 ± 2.36 in the T-PRF group, and 2.38 ± 1.41in the PRF group) and the vast majority has their pain relieved by the seventh day (mean = 0.25 ± 0.71 in the T-PRF group, and 0.00 ± 0.00 in the PRF group). On the other hand, edema was absent or slight edema was observed for all patients in the both groups in the first day postoperatively while in the 7th day no patient in the both groups had any degree of post operative edema. However, in the 3rd day, no patient was free of edema in the both groups and all patient's edema score ranged from slight to mild but with no significant difference at any time point between the two groups. No nasal bleeding was observed in any patient in any group at any time point during the study. The results regarding intra and post operative complications obtained from this study and data collected from the study of Trombelli et al. (29) emphasize that transcrestal sinus lifting approach is a minimal invasive procedure where no complications were observed either during the surgical procedure or after the completion of surgery such as bleeding or sinus membrane perforation. However, despite pain score heavily depends on patients' self-reports and should be interpreted carefully, all the patients in both studies had neglectable pain score in the 7th day.

Regarding primary and secondary implant stability, there was no statistical difference between the two groups but there was a significant difference between the two readings in the same group where *P* value was < 0.0001 for the both groups. The mean percentage of increase in implant stability was (26.37±13.46 for T-PRF group while it was 34.76±15.38 for PRF group) but with no significant difference between the research groups. The six-month healing period given for the patients after implant placement that allowed non disturbed osteointegration of the placed implant resulted in this increase in the readings of secondary implant stability.

Mean of the residual bone height (RBH) was 6.06±0.66mm and 6.13±0.59 mm in T-PRF and PRF groups respectively with no significant difference. Implant protrusion length (IPL) mean that was slightly higher in T-PRF group (2.44±0.58mm) when compared to PRF group (2.13±0.63mm) isn't related to different properties of the grafting material, but to the extent of the implant protruding into the maxillary sinus due to insufficient residual bone height. However, sinus bone gain SBG that equals implant protrusion length added to Peri-implant sinus bone level (PSBL) was higher in T-PRF group (mean =2.51±0.55mm) where PRF group (mean 2.26±0.57mm) but with no significant difference. From these data we can conclude that the amount of SBG in this study coincide with other data from literature where Diss et al. (30) who placed 35 implants in posterior atrophic maxilla of 20 patients

using osteotome in sinus lifting where mean RBH was 6.6mm and they used PRF as a sole grafting material when 3.2 mm SBG mean was revealed. The same mean of RBH was recorded in another study where 3.4 mm SBG was obtained by using PRF as sole grafting material (31).

These results could be justified by the fact that most of SBG obtained by using platelet products as a grafting material is slightly higher than the IPL due to either physical properties of clot that is unable to push sinus membrane to higher level when compacted beneath the elevated membrane, or due to biological properties of platelet products where they are rapidly dissolved before the process of bone formation begins. However, 4mm SBG was obtained in another study using PRF in transcrestal sinus lifting and results were explained by the recorded values of RBH that was less than 5mm in all cases included in the study (23).

Concerning bone density around implant apex measured using gray scale values, the mean immediate post operative x-ray was (357.40±46.29) for T-PRF group that increased to (1004.03±19.29) after six months. In the PRF group the bone density mean was (342.31±43.51) that increased to (985.43±34.90) with no evidence of significant correlation between the study groups, neither immediate post operatively or at 6 months post operative time point, despite T-PRF group had a slight better mean of post operative bone density value. However, a significant difference was found in the percentage of bone density increase around implant apex between the two time points in the same group for the two points with (P value < 0.0001), but no significance was obtained when comparing the percentage of density gain between the two study groups. This bone density reading come in line with the study (32) that used grayscale values obtained from CBCT for bone density measurement that concluded that bone density for cancellous bone density in healthy patients was 906.918 (±185.40), which means that platelets products are able to induce bone formation around implant apex when used as a grafting material in transcrestal sinus lifting procedure. Moreover, this data obtained regarding the increase in bone density around implants while using PRF as a sole grafting material in sinus lifting procedure, which resulted in a bone density that is similar to density of cancellous bone after 6 months of surgery, was also documented in Tajima et al. study (33), as well as Mazor et al. (17) when he mentioned that the newly formed bone after using PRF in sinus lifting didn't look very dense or cortical. In the context, bone quality measure obtained from CBCT when taken without bone grafting correlates to clinical bone quality, while the increased radiographic bone density measurement seems to be not associated with the clinical bone density, with history of bone grafting especially when xenografts are used (34).

CONCLUSION

In conclusion, that no clinical or radiographic difference was found between T-PRF and PRF, despite SBG was slightly higher in T-PRF group. However, both T-PRF and PRF are successful sole grafting materials when used in transcrestal sinus lifting with good clinical results.

CONFLICT OF INTEREST

The authors informed that they have no conflict of interest.

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