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ASSESSMENT OF SINUS TENTING OF SIMULTANEOUS DENTAL IMPLANTS WITH AND WITHOUT SOLID PLATELET RICH PLASMA FOR MAXILLARY SINUS LIFT WITHOUT GRAFTING

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ABSTRACT

Introduction: Platelet-rich plasma (PRP) is an autologous product with a native content of fibrinogen and a high concentration of platelets (5–10 times higher than whole blood) Platelets contain growth factors that can trigger cell reproduction and stimulate tissue regeneration or healing. So, we used PRP around implants to accelerate healing and enhance bone formation quality. **Aim:** This clinical study aimed to assess sinus tenting of simultaneous dental implants with and without PRP for maxillary sinus lift without bone grafting. **Methods:** This clinical, trial was carried out on ten patients required bilateral sinus lifts in upper posterior region. Implants inserted simultaneously with the sinus lift procedure without grafting. Bilateral sinus tenting was performed for each patient, then the patients were grouped as: Group I (patients' one side as a study group): obtained a solid PRP was administered above and around the implant. Group B (patients' other side as a control group): left without loading solid PRP. The second-stage surgery had been conducted to expose the implant fixture & for prosthetic phase completion after 6 months. Assessments were done clinically by Visual analog scale for pain, measurement of edema, implant stability assessment by Osstel (ISQ), surgery time factor and postoperative complication; and radiographically to assess the bone density, vertical bone gain after six months and crestal bone changes. **Results:** No significant difference existed between two groups in pain, edema scores, implant stability, bone density and vertical bone gain at T0, no significance differences between two groups were found in bone density, vertical and crestal bone changes at T6. Significance differences between both groups existed with better results in study groups in pain and edema at T1 and T2 and higher values of implant stability in study group at T6. Surgical time was longer in study group. Tenderness and nasal obstruction were lesser in study group and no nasal bleeding in both groups. **Conclusions:** Application of solid PRP in sinus tenting procedure of simultaneous dental implants for maxillary sinus lift without bone grafting can improve pain, edema scores and implant stability.

INTRODUCTION

Implantology has developed into a well-respected course of therapy for partially or fully edentulous jaws. A crucial requirement for the placement of implants that guarantees long-term stability is appropriate osseointegration depending on the recipient site's minimal bone width and height. The atrophic posterior upper jaw rehabilitation poses a challenge for specialists in this regard. The pneumatization of the maxillary sinus and the resorption of alveolar bone following

the maxillary posterior teeth extraction lead to both vertical and horizontal resorption of bone, and decreases the amount of bone that can be used for a typical implant-prosthetic therapy. Different surgical methods have been devised to repair the posterior maxilla in cases when there is not enough bone volume[1, 2].

Augmentation of the maxillary sinus is a surgical technique used to enhance the amount and quality of bone in the maxillary posterior edentulous area. The atrophic maxilla's increased bone quantity and quality enable the implantation of an ideal-sized implant [3, 4].

Several surgical procedures were developed to raise the sinus membrane and provide access to the sinus cavity. Approaches to elevating the sinus membrane are usually divided into two categories. In the first, the maxillary sinus floor is lifted via a lateral window in a two-stage procedure. During this phase, autologous, demineralized, xenogeneic, or mineralized allogeneic bone, as well as alloplasts, are used to reinforce the maxillary sinus membrane. The implant is then inserted following a recovery period. With the second method, membrane lifting and implant implantation can be done in the same appointment because it is a one-stage process that uses a transalveolar or lateral technique[5, 6].

The sinus membrane elevation can be carried out using grafting materials or not. Lundgren et al. were the first to propose not using grafting materials and placing implants immediately; It necessitates a residual vertical alveolar bone height in the maxilla's posterior zone that is sufficient to maintain the augmented Schneiderian membrane and provide the primary stability of the implant, permitting a clot to form around the implant's exposed surface in the sinus cavity [7-9].

Several bone substitutes and biomaterials were proposed for use in maxillary sinus floor lift treatments, primarily for the purpose of maintaining elevated space. These include autogenous/autograft bone, alloplastic bone with varying degrees of success, and freeze-dried bone allograft, xenograft. Conversely, other authors have emphasized the significant regenerating potential that comes from only the blood clot and haven't suggested the insertion of additional grafting material; in these instances, the implant apex is the only structure supporting the Schneiderian membrane. Biologically active molecules, like mesenchymal stem cells (MSCs), autologous platelet concentrates (APCs), and bone morphogenic proteins (rhBMPs), were used as substitute materials for bone augmentation operations in an effort to stabilize the blood clot and promote healing. APCs are biological substances derived from the centrifuged patient's venous blood [10-13].

Although sinus lift accompanied with a bone graft was deemed the optimal choice, various bone substitutes, including materials of heterogeneous, homogeneous, and alloplastic origin, have been developed in light of some of the drawbacks and systemic limitations, including a requirement for an additional surgical site and subsequent complications. These materials' drawbacks involve the possibility of contamination and transmission of diseases, as well as their solely osteoconductive qualities. Technically challenging operations and the replacement of graft materials are required. According to certain research, placing an implant in the sinus cavity without using any graft materials may encourage the growth of new bone. In particular, blood cells stimulate the development of osteoclasts from bone precursor cells, and these activated osteoclasts in turn trigger additional osteoclasts that build new bone and start the process of producing bone [14-17].

Platelet-rich plasma (PRP) is an autologous product with a native content of fibrinogen and a high concentration of platelets (5–10 times higher than whole blood). Owing to the elevated platelet concentration, the PRP has an abundance of platelet granules, that are rich in growth factors (GFs), including platelet-derived growth factor (PDGF), epidermal growth factors (EGF), transforming growth factor-beta (TGF-b), and vascular endothelial growth factors (VEGF). These substances are essential for promoting the healing process. Because of all these elements, PRP encourages mucosal healing and angiogenesis, which makes it a desirable product for use during surgeries [18-20].

Its autologous origin eliminates the chance of immunological reactivity, disease transmission, and cross-contamination. PRP has been widely used as an adjuvant in several dental surgical techniques. It is a significant source of GFs and cytokines that can promote local hemostasis, modulate tissue inflammation, vascularize tissues, accelerate the formation of new bone, and enhance scaffold mechanics. Utilizing PRP has demonstrated advantages in the following fields: mandibular fracture reconstruction; extraction socket healing; management of periodontal infra-bony defects; management of bisphosphonate-associated osteonecrosis; distraction osteogenesis for mandibular reconstruction; and utilization as an implant coating material in rapid loading protocols [18, 21, 22].

Platelet concentrates, as first reported by **Whitman *et al.*** [23] are acquired following a blood sample's centrifugation. Various methods have been created to produce a range of preparations. Centrifugation of citrated blood is utilized to prevent coagulation during the procedure, yielding liquid PRP and plasma rich in growth factors (PRGF). Calcium chloride and/or thrombin are included to facilitate fibrin polymerisation in its gel state, resulting in the creation of a low-density fibrin gel [24].

According to a review by **Strauss *et al.*** [25] of 167 participants, the use of PRP plus autologous bone for sinus lift does not appear to have any further positive impacts on the following parameters: survival rate of implants, height of bones, stability of implants, marginal bone level, density of bone, volume of laminar bone and tissue, resorption of bone grafts, angiogenesis, and healing of soft tissues. PRP treatment in conjunction with xenografts (127 patients) [26,27] or beta-tricalcium phosphate (F-TCP), that was investigated in 35 participants[28], does not seem to provide any extra therapeutic advantages.

Nevertheless, research conducted on animals invivo has demonstrated that using platelet concentrates alone for sinus augmentation can result in a mean height of novel produced bone of up to 3.6 mm [29], and current clinical research has shown that they may be an effective treatment for sinus augmentation on residual ridges less than 5 mm [30] and that, when implants are concurrently implanted, they may provide a mean height of freshly produced bone of up to 4 mm [31].

Several studies were comparing sinus lifting with different grafting material. Nevertheless, there is little information available about using solid PRP in sinus tenting procedure of simultaneous dental implants for maxillary sinus lift without grafting. Our study aimed to evaluate sinus tenting of simultaneous dental implants with and without PRP for maxillary sinus lift without grafting.

No significant difference is present among both groups, and this was found to be the null hypothesis of this study.

MATERIALS AND METHODS

This clinical, interventional, prospective, and randomized controlled trial was carried out on individuals chosen from the outpatient clinic, Department of Oral and Maxillofacial Surgery, Suez Canal University and Faculty of Dental Medicine, Zagazig University. A work on 10 participants (4 males and 6 females) required bilateral sinus lifts to replace the missing upper posterior teeth with implants inserted simultaneously with the sinus lift procedure without grafting. Bilateral sinus tenting was performed for each patient, with solid PRP loaded around and above the implant on one side (study group) and the other side lefted without solid PRP (control group).

This study had been approved by the ethical committee, Faculty of Dental Medicine, Al Azhar University with the number of (NoAU-AREC20240001-2). All patients obtained comprehensive explanations of the surgical techniques, any complications, the entire study schedules, and the photographs that were used in the scientific study and signed the consent form.

Inclusion criteria was healthy patients who were more than 18 y, individuals requiring dental implants in the bilateral posterior edentulous maxilla with non-augmented native bone, decreased height of vertical bone of at least 5 mm, individuals with implant placement diameters ranging from 4 to 5 mm, bone quality of D2 or D3 and accepted inter-arch space.

Exclusion criteria was individuals have current infections or conditions that impair healing of wounds and bones. Individuals diagnosed with maxillary sinusitis or related pathologies. Individuals had bone augmentation. Individuals who received prescription drugs that may influence bone metabolism, including steroids, bisphosphonates, and rheumatologic treatments. (For instance, immunosuppressive medications). Individuals have a history of radiation treatment to the head or neck. Individuals who are pregnant or lactating. Systemic or localized conditions that contraindicate the implantation or sinus procedure. Bad oral hygiene or inadequate dental maintenance. Bruxism, clenching, and smoking behaviors.

Patients were divided into two groups: Group A (patients' one side as a study group): obtained a solid PRP administrated above and around the implants. Group B (patients' other side as a control group): left without loading solid PRP. Bilateral sinus tenting of a simultaneous dental implant with sinus lifting and without grafting was performed for each patient.

Preparation of solid platelet-rich plasma:

The participant's own blood had been utilised to create the solid platelet-rich plasma just prior to surgery. 40 ml of collected venous blood were equally placed into 8 tubes each of 5 ml which previously loaded with anticoagulant citrate dextrose. The tubes underwent centrifugation at 1300 rpm for a duration of 10 minutes. Following the initial spin, the total blood separates into two layers: the upper straw-colored layer, which contains platelets poor plasma (PPP), and the bottom red-colored blood cell layer. The PRP layer is located in the border layer between both layers. After aspirating and transferring the top 2 mm of the red layer (PRP) and the upper straw colored plasma layer (PPP) into a new tube, the mixture is centrifuged once more for 15 minutes at 3500 rpm. As a result, the bottom layer is dark yellow and contains highly concentrated platelet-rich plasma, whereas the top section is clear yellow serum. Approximately 0.6 ml aspirated PRP from each tube were transferred into a different syringe. To finalize the activation and gel phase transformation of the platelet rich plasma, 0.5 ml of the produced activator, consisting of 1 ml of 10% calcium chloride solution and 80 units of

USA bovine thrombin, has been incorporated to the newly created PRP and allowed to incubate for 2 minutes (each 1 ml of PRP necessitates 0.1 milliliter of activator for activation).

Surgical Procedure

Pre-operatively one hour before the surgery, Antibiotic treatment (Augmentin 1g (oral), gsk GlaxoSmithKline, Egypt) was administered to each patient. Each participant had been instructed to wash their mouth with an antiseptic mouthwash 0.12% chlorhexidine (Hexitol Mouthwash, ADCO, Egypt). The patient was given a local anesthetic for the procedure (Articaine 4% with Epinephrine 1:100,000) (Artinibsa 4%, Inibsa, Spain) in palatal and vestibular aspects. A trapezoidal flap was reflected to fully reveal the maxillary sinus' lateral wall and the alveolar ridge. With the lateral access window open, great care was taken to significantly raise the sinus membrane utilising an electric motor drill equipped with suitable water cooling. Using a pilot drill to make the first hole then proceed with the drilling sequence, making sure the last drill utilised has a diameter that is one millimeter less than the implant. The implant fixture (4.5 mm in diameter and 10 mm in length) (NUVO, Straumann, USA) was placed from the crystal bone and extended into the sinus space. The alveolar bone that was preserved served as primary stability. The raised sinus membrane was supported by an implant to maintain the elevated sinus space, rather than using allogenic or autogenous bone substitutes as grafts inside the sinus space. In the research group, the area between the sinus membrane and the sinus floor around the fixture had been filled with solid PRP (Figure 1).

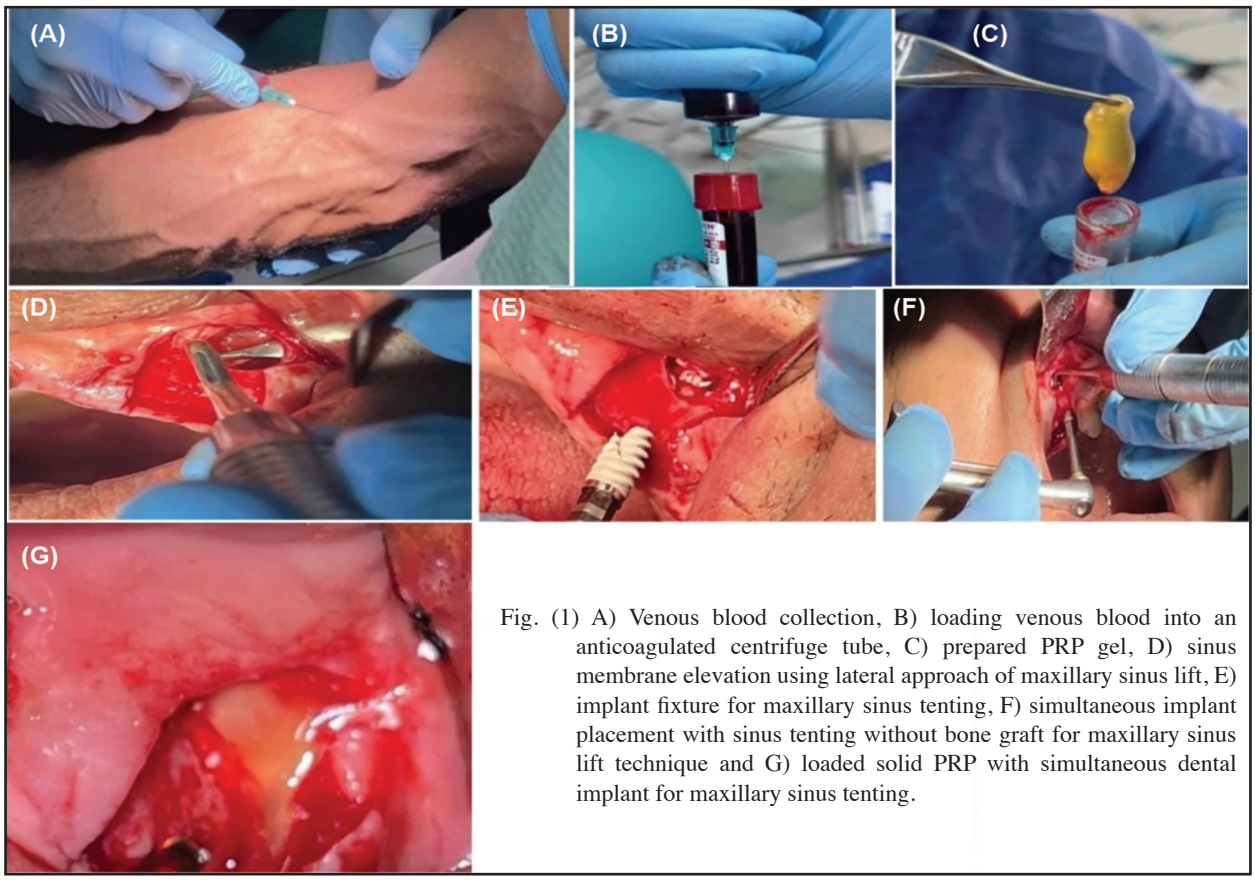

Fig. (1) A) Venous blood collection, B) loading venous blood into an anticoagulated centrifuge tube, C) prepared PRP gel, D) sinus membrane elevation using lateral approach of maxillary sinus lift, E) implant fixture for maxillary sinus tenting, F) simultaneous implant placement with sinus tenting without bone graft for maxillary sinus lift technique and G) loaded solid PRP with simultaneous dental implant for maxillary sinus tenting.

In the control group, the raised sinus membrane had been tented over the fixture without the application of PRP. Then flap was sutured with Vicryl 3/0 sutures (3-0 Vicryl Suture, Assut Medical, Switzerland). After operation, the participant obtained Amoxicillin with Clavulanic acid antibiotics (Augmentin 1g (oral), gsk GlaxoSmithKline, Egypt), nonsteroidal anti-inflammatory drugs (Cataflam, Novartis Pharmaceuticals Corporation, Egypt), and 0.12% chlorhexidine for 5 days. The sutures subsequently excised seven days post-surgery. The operation had been conducted depending on a two-stage procedure. The second-stage surgery had been conducted to expose the implant fixture & for prosthetic phase completion after 6 months.

Postoperative Assessment

Clinical Assessment

Presence or absence of intra or postoperative complications

The biological issues, comprising peri-implant mucositis and peri-implantitis, as well as mechanical consequences like implant failure and fractures, were evaluated.

Postoperative pain

The participants were instructed to indicate the amount of discomfort they experienced on a 10-cm horizontal line utilizing a visual analogue scale (VAS), with 0 signifying no pain and 10 representing extreme pain. The amount of discomfort was measured one, three and seven days after the operation (Figure 2).

Postoperative edema

The patient's teeth were in occlusion and she was seated upright. On the surface of the skin, a pen marker was used to mark four points. The ear tragus, mouth corner, gonion, and the eye's external canthus are the four points. The distances between the gonion and the eye's external canthus and between the lip commissure and ear tragus were measured preoperative, one, three and seven days postoperative to assess the amount of facial contour in (cm). The baseline measurement was the average of the total of both distances. The size of edema was measured one, three and seven days after the operation.

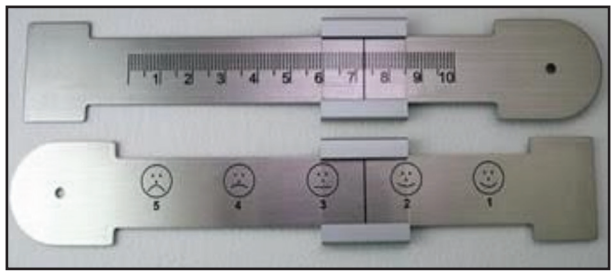

Fig. (2) Visual analog scale (VAS) ruler

Surgical Time factor

Time to perform surgical procedures starting from incision to suturing was measured in the two studied groups using a stopwatch (in minutes).

Implant stability

The Osstell ISQ Implant Stability Meter's implant stability quotient (ISQ) had been utilised to assess the primary implant's stability. Because of the implant's posterior position and exposure to strong occlusal stresses, we measured the mean values of the buccal and occlusal ISQ. After six months of surgery, the stability of the implant was reassessed.

Radiologic Assessment

Preoperative cone beam computed tomography (CBCT) (Sordex, Helsinki, Finland). was performed (T1) to determine the remaining bone dimensions.

A second CBCT was carried out six months after the sinus lift procedure (T2) to assess the density and vertical height of the formed bone surrounding the implant inside sinus space.

The pre- and post-operative CBCT cross-sections of the implant site were analyzed, and the medial-to-lateral diameters of the maxillary sinus at the implant apex were evaluated for assessing the extent of bone production relative to the maxillary sinus morphology. Furthermore, the maxillary sinus anteroposterior shapes were determined in relation to the neighboring teeth; CBCT was also used to examine the implant's surrounding bone morphology and the height of the implant's apex.

Statistical analysis

Analyzing data was done using a program named the SPSS for Windows (Standard version 26) (SPSS Inc, USA). The Shapiro test was the first chosen to test the normality of data. Description of qualitative data was done using numbers as well as percentages. The Monte Carlo test and the Fisher exact one was utilized to test the correlation between categorical parameters when expected cell count was found to be below 5. Continuous parameters had been introduced as mean ± SD which stands for (standard deviation) for the normally distributed data and both groups had been contrasted with independent t-tests. For the previously mentioned statistical tests, Significance threshold is fixed at a 5% level (p-value). The results deemed to be important when $p \leq 0.05$. The lesser the p-value, more significant results obtained. The tests were considered significant.

RESULTS

20 sinus floor augmentations were carried out on 10 individuals in this research. The cohort included 4 men and 6 females, with ages ranging from 23 to 62 years and a mean age of 42.5 ± 15 years. The average alveolar ridge' height from the marginal crest to the maxillary sinus floor was 5.84 mm ± 0.79 mm (Range: 4.5 - 6.8 mm) bilaterally, as seen in (table 1 and table 2).

Table (1) *Description regarding age, gender, preoperative bone width, implant location and height and implant diameter and length. In study side (with PRP)*

Case #	Gender	Age	Implant location	Preoperative bone height (mm)	Preoperative bone width (mm)	Implant length (mm)	Implant diameter (mm)
1	F	23	Premoalr	6.1	7	10	4
2	F	28	Molar	5.2	7.2	10	4
3	F	35	Molar	6.3	8	10	4
4	M	62	Premolar	4.5	6.8	10	4
5	M	50	Molar	5	6.9	10	4
6	F	44	Premolar	6.8	7.4	10	4
7	F	36	Premolar	6.3	7	10	4
8	M	30	Molar	4.8	7.1	10	4
9	F	25	Molar	4.9	7.5	10	4
10	M	56	Molar	5.7	7.9	10	4

PRP: Platelet-rich plasma.

Table (2) *Description regarding age, gender, preoperative bone width, implant location and height and implant diameter and length. In control side (without PRP)*

Case #	Gender	Age	Implant location	Preoperative bone height (mm)	Preoperative bone width (mm)	Implant length (mm)	Implant diameter (mm)
1	F	23	Premoalr	6.5	7.3	10	4
2	F	28	Premoalr	5	7.1	10	4
3	F	35	Molar	6	6.9	10	4
4	M	62	Molar	4.7	7.1	10	4
5	M	50	Molar	5.8	7.9	10	4
6	F	44	Premoalr	6.4	7.4	10	4
7	F	36	Premoalr	6.3	6.8	10	4
8	M	30	Premoalr	5.2	7.5	10	4
9	F	25	Molar	4.8	7	10	4
10	M	56	Molar	5.7	7.7	10	4

PRP: Platelet-rich plasma.

Twenty implants had been inserted in the maxillary posterior teeth, 10 in study side and 10 in control side, 11 at the molar region and 9 in premolar region. The participants obtained 10.0 mm length implants. All the implants had a diameter of 3.5 mm.

Pain (VAS scores)

After one day, no statistically significant difference existed among both groups (P-value = 0.117). After three days, study group revealed statistically significantly decreased pain score compared to control group (P-value = 0.0125).

After seven days, study group revealed statistically significantly lower pain score than control group (P-value = 0.0075). as shown in table 3:

In study group, a statistically significant change existed in pain scores by time (P-value <0.005). after first day there was no decrease in pain, third day there was slight relief in pain, after seventh day there was mild or almost no pain.

As regards control group, a statistically significant change existed in pain scores by time (P-value <0.005). after first day there was no decrease in pain, third day there was slight relief in pain, after seventh day there was mild pain.

Table (3) *Shows comparison of VAS between the two groups*

		Study group	Control group	p-value
Day 1 pain	Mean ± SD	6.44 ± 1.11	7.04 ± 1.14	0.117 (NS.)
Day 3 pain	Mean ± SD	2.63 ± 0.64	5.14 ± 0.88	0.0125 (Sig.)
Day 7 pain	Mean ± SD	1.01 ± 0.28	2.5 ± 0.62	0.0075 (Sig.)

Edema scale

After one day, no statistically significant difference existed among both groups (P-value = 0.106). After three days, study group showed statistically significantly less edema compared to control group (P-value = 0.0105). After seven days, study group showed statistically significantly less edema compared to control group (P-value = 0.0066) as shown in table 4:

Table (4) *shows comparison between the two groups in edema measurements*

		Study group	Control group	Test, p-value
Day 1	Mean ± SD	10.79±0.49	11.03± 0.53	0.106 (NS)
Day 3	Mean ± SD	9.06 ± 0.44	10.62±0.48	0.0105 (Sig.)
Day 7	Mean ± SD	8.06 ± 0.57	9.34±0.81	0.0066 (Sig.)

In study group, a statistically significant decrease in edema existed by time (P-value <0.002). after first day there was no decrease in edema, third day there was slight decrease in edema, after seventh day there was mild or almost no swelling.

As regards control group, a statistically significant change in edema existed by time (P-value <0.002). after first day there was no decrease in edema, third day there was slight decrease in edema, after seventh day there was mild swelling.

Implant stability assessment using Osstell (ISQ)

First in primary stability which is measured immediately after implant insertion, no statistically significant difference existed among ISQ scores in the two groups (P-value = 0.181). After 6 months, the study group shows statistically significant higher ISQ scores than control group (P-value = 0.057) as shown in table 5:

Table (5) *shows a comparison of ISQ between the two groups*

		Study	Control	Test, p-value
ISQ Immediately	Mean±SD	69.7±6.7	72.4±5.7	0.181 (NS)
ISQ 6th month	Mean±SD	88± 4.7	75.2±4.4	0.057 (Sig.)

In study group, a statistically significant increase existed in ISQ scores at second stage (P-value = 0.017). In control group, a statistically significant increase existed in ISQ scores at second stage (P-value = 0.0209) (Table 6).

Table (6) *shows a comparison of ISQ in the same group immediately and after 6 months*

		Study group		Control group	
		Mean ±SD	p-value	Mean ±SD	p-value
ISQ Immediately vs 6th month	Pre-operative	69.7 ±6.7	< 0.017 (Sig.)	72.4 ±5.7	< 0.0209 (Sig.)
	6th month	88 ±4.7		75.2 ±4.4	

Bone density (HU)

Whether pre-operative or following six months, no statistically significant difference existed among bone density measurements in the two groups (P-value = 0.107) and (P-value = 0.389), respectively as shown in table 7:

Table (7) *Shows comparison of bone density between the two groups*

		Study	Control	Test, p-value
Bone density Preoperative	Mean ± SD	99.25 ±10.03	93.15 ± 9.43	0.107 (NS)
Bone density 6th months	Mean ± SD	131.06 ± 10.37	125.05 ± 9.31	0.389 (NS)

In the two groups, a statistically significant decrease in bone density existed following six months (P-value = 0.003) and (P-value = 0.003), respectively as shown in table 8:

Table (8) *Shows a comparison of bone density changes within each group*

		Study group		Control group	
		Mean ±SD	p-value	Mean ±SD	p-value
Pre-operative vs 6th month	Pre-operative	99.24 ±10.02	< 0.003 (Sig.)	93.14 ±9.44	<0.003 (Sig.)
	6th month	131.06 ±10.37		125.06 ± 9.31	

Vertical bone gain after six months (mm)

No statistically significant difference existed among vertical bone gain following six-months period in the two groups (P-value = 0.112) as shown in table 9.

Table (9) *Shows a comparison of vertical bone gains between the two groups*

		Study	Control	Test, p-value
Vertical bone gain after 6 months (mm)	Mean ±SD	8.64 ±7.22	7.66 ±6.4	0.112 (NS)

In the two groups, a statistically significant increase existed in bone height (vertical bone gain) following six months in both groups (P-value = 0.001), (P-value = 0.001), respectively.

Crestal bone changes (mm)

No statistically significant difference existed among both groups (P-value = 0.310) as shown in table 10:

Table (10) *Shows a comparison of crestal bone changes between the two groups*

		Study	Control	Test, p-value
Crestal bone changes (mm)	Mean ± SD	-1.81 ± -1.62	-1.67 ± -1.65	0.310 (NS)

In the two groups, there is a statistically significant decrease in crestal bone height following six months in both groups (P-value = 0.001), (P-value = 0.001), respectively.

Surgery time factor

Surgery time was longer in study group as considering venous blood collecting and PRP preparing, bone removing to expose sinus lateral wall and lifting Schneiderian membrane and finally, we fill the space between the sinus membrane and the floor of the sinus around the fixture was filled with the solid PRP (half an hour at least longer in study group).

Post operative complication

Tenderness and nasal obstruction were lesser in study group. There was no nasal bleeding in both groups.

DISCUSSION

In the posterior maxilla, resorption of bones and maxillary sinus pneumatization after tooth extraction is frequent. They may result in insufficient dimension of bones for appropriate size/length implant placement by reducing bone quantity and deteriorating the bone quality [32]. The current work was performed to assess the utilization of PRP as a sole agent in edentulous posterior maxilla augmentation after simultaneous implant placement with sinus lifting.

The patients that were chosen had no systemic medical conditions or diseases that could affect bone resorption and formation. This was consistent with retrospective research by **Moy *et al***. [33] that identified systemic disease as a major risk factor for failure of the implants.

Furthermore, this study did not include heavy smokers. This was in line with a study by **Holahan *et al***. [34] that found patients who smoked at the time of the placement on implant had a 2.6 times increased risk of implant failure contrasted to those who did not smoke.

All patients in this study maintained good oral hygiene throughout the pre- and post-operative follow-up, and those with parafunctional behaviors like clenching or bruxism were also excluded. This matched a work by **Porter and von Fraunhofer** [35].

Additionally, following an ear, nose, and throat (ENT) consultation, participants in this study were chosen without any sinus pathosis. This is consistent with a work by **Torretta *et al*.** [36] which suggested that patients undergoing sinus membrane elevation benefit from meticulous comprehensive preoperative treatment, including an ENT assessment. Since implant placement and maxillary sinus augmentation operations provide a danger for transmitting novel germs into the sinus, antibiotics were administered both preoperatively and postoperatively in the present research. As noted by **Trieger** [37], **Laskin *et al*** [38], and was in line with **Sharaf *et al*** [39], the administration of antibiotics has been shown to not only decrease the occurrence of postoperative infections but additionally to considerably lower the risk of failure of the implants.

The lateral window had been utilized for this investigation in order to facilitate appropriate visualization of the Schneiderian membrane as well as proper and simple application of the gel-like PRP this is in agreement with **Shulman and Jensen**. At least 5mm of residual bone height has been suggested for simultaneous implant insertion with sinus floor elevation surgery for acheiving appropriate initial implant stability in accordance with **Kaneko *et al*** [40].

After six months of surgery, there was no implant failure when the lateral window approach was utilized for sinus membrane elevation, yielding a 100% success rate. **Wallace and Froum** [41] reported a survival rate of 91.8%, which is consistent with our findings.

The biomaterials were utilized as scaffolds and space maintainers during sinus-lift to encourage bone repair in the subsinus region. According to **Browaeys *et al*** [42], there was a common opinion that a lot of biomaterials could be used in the sinus because of the membrane. As a result, it is simple to perform the lateral sinus-lift procedures without the need for any material, especially for minor grafting volumes [43]. According to some researches, the actual bone development is always limited when no augmentation is employed. Additionally, implant apical ends may become entangled in the sinus connective tissue and fail to osseointegrate [44, 45]. These findings contrasted with our findings which agree with the results of **Lundgren *et al***. and **Anderson *et al.*** [46] who found that implants inserted with lateral approaches for maxillary sinus lift using tenting technique alone had an excellent survival rate.

PRP is a concentrate that is derived from the patient's centrifuged peripheral venous blood and is used as grafting material. Three GFs that are very prevalent in PRP are PDGF, TGF, and VEGF. These factors can be involved in a variety of cellular processes, like cell differentiation, tissue repair, angiogenesis, and increased collagen synthesis [23,47].

Until **Marx *et al***. found that using PRP in addition to autologous bone would produce a notably better result, this strategy had already been used in other medical specialties, such as dermatology [48].

PRP activation with thrombin or calcium chloride is regarded as an essential stage in the PRP preparation process because it starts the platelets' degranulation, which releases growth factors from alpha granules and aids in the formation of a platelet gel or matrix [49, 50].

Three days following grafting in the recipient site, PRP stimulates the following cellular processes: proliferation of fibroblasts and osteoblasts, neoangiogenesis, and promotion of the freshly formed bone matrix's mineralization[51,52]. This could explain our findings that showed early improvement in the clinical parameters pain and edema in PRP group as PRP has an effective role in healing process.

The lack of postoperative inflammation and complications in the PRP group can be attributed to the inhibition of monocyte cytokine production and restriction of inflammation by platelet products [53]. New research also suggests that platelets first prevent activated macrophages from releasing interleukin-1 (IL-1). The first reduction of the response to inflammation might have significant implications for elucidating the mechanism by which platelet-rich products operate as anti-inflammatory agents which agreed with our results [54].

According to **Sul *et al*** [44] ; **Dohan *et al*** [55], a PRP coverage over the sinus membrane may enhance membrane healing, stimulate the periosteum, and may be stabilize a novel bone volume at the end of the implant. The platelet and fibrin contents of the PRP may have an impact on these effects which agree with our results that showed significant higher ISQ scores in PRP group in follow up visits [56, 57]. But according to **Esposito *et al*** [58] ,there was no proof that PRP therapy enhanced the sinus lift with autogenous bone or bone substitutes procedures clinical results.

Implant insertion simultaneous with sinus elevation is a commonly employed clinically documented procedure. **Blomquist *et al***. noted the benefit of this procedure in reducing expenses and duration of surgery, in addition to the fact that loading can be done immediately, so permitting graft maintenance [59]. Our study was consistent with the last-mentioned study as in our study primary stability can be achieved with simultaneous immediate implant insertion with sinus lifting. Numerous investigations have shown that there are no histological or clinical differences between implant placements that are made immediately after maxillary sinus elevation and those that are made later [41, 60]. However, it is important for achieving the main stability in the remaining bone without any implant motion. At least 5 mm of bone height is required for placement of implants in order to assure the implant's primary stability, which in turn ensures the treatment's effectiveness [61].

None of bone graft materials were used into the sinus in the current study after the membrane was raised, however, bone formed surrounding implants. this agreed with **Thor *et al*** [62]; **Pjetursson *et al***.[63] Clinical research has demonstrated that inserted dental implants can naturally regenerate new bone surrounding them, negating the need for the use of bone augmentation. However, when implants are inserted at the time of sinus lifting and allowed to osseointegrate naturally without the requirement for autogenous bone or allografts, the clear benefits in terms of cost-effectiveness and time-saving and associated with lower morbidity become evident which was consistent with our study [64].

Our results, which showed no significant variation in primary stability at implant insertion among both groups but following 6 months, the PRP group showed statistically significant higher implant stability than control group, which are inconsistent with a work by **Inchingolo *et al*** [65]. that examined a cohort of 127 participants in need of a maxillary sinus lift. Anorganic, organic, or autogenous bone was combined with PRP in half of the patients; PRP-free grafting material was given to the control group. the test group using PRP demonstrated a statistically substantial improvement in osseointegration as regard primary stability and peri-implant bone quality assessed in tomographic sections using a 3D program.

Norton & Gamble [66] proposed that Hounsfield units, that are directly correlated with tissue attenuation coefficients obtained from CT scans, can be used to assess bone density. and found that for 139 sites, the average bone density was 682 HU. Conversely, the anterior and posterior maxilla had mean bone densities of 696 and 417 HU, respectively. This is consistent with findings from **Sogo *et al*** [67], who examined the bone density of the posterior maxilla in thirty individuals and came to the conclusion that, in accordance with Misch's classification, the bone in the posterior maxilla had been categorized as D3 (350–850 HU) or D4 (150–350 HU), In the current work, the results were consistent with the last mentioned studies where the density of the new bonelike tissue around implants in our study ranged from 250-700 HU. When CBCT had been utilized for comparing both groups, the PRP group had no significant variation in bone quantity and density than the non-PRP group. This was not in line with the findings of **Pacifici *et al.*** [68] and **Schaaf *et al***. [69], who claimed that PRP guarantees superior mineralization in terms of rate and degree.

In the current investigation, none of the patients subjected to wound dehiscence following surgery, and a CBCT radiographic evaluation six months after surgery showed no signs of inflammation or fluid accumulation.

In terms of procedure-related complications, perforation of sinus membrane was the most often noted, occurring in 61 of the 397 maxillary sinus lift procedures that were documented. When **Ardekian *et al.*** [70] assessed the rate of perforation of membrane in this kind of surgery, they came to the conclusion that no statistically significant association existed among perforation of membrane and the implant success rate, and that this complication is more common in remaining alveolar bone with a lower height.

Each implant effectively met the requirements stated by **Buser *et al.*** [71] as there were no documented surgical consequences, like wound dehiscence, maxillary sinus infections, membrane perforation, intraoperative bleeding, epistaxis, periimplantitis or loss of primary implant stability. At the most recent follow-up, all implant was stable and every prosthesis was operating as intended. None of the patients had any pain or edema during the follow-up period, either before or after prosthesis loading.

CONCLUSIONS

Application of solid PRP in sinus tenting procedure of simultaneous dental implants for maxillary sinus lift without grafting can improve pain, edema scores, implant stability and postoperative complication.

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