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EVALUATION OF VESTIBULAR SOCKET THERAPY USING XENOGRAFT WITH AND WITHOUT PLATELET RICH FIBRIN FOR MANAGING TYPE II EXTRACTION SOCKETS FOR IMMEDIATE IMPLANT PLACEMENT IN THE ESTHETIC ZONE

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ABSTRACT

Objective: To assess the effectiveness of Vestibular Socket Therapy (VST) in managing class II sockets in the esthetic zone when the graft material consists solely of xenogenic bone, both with and without the addition of platelet-rich fibrin. **Material and Methods:** Patients were randomly assigned to two groups, each comprising seven patients. Group I: Patients were treated with immediate implants in the esthetic zone using the VST technique with xenograft and platelet-rich fibrin (PRF). Group II: Patients were treated with immediate implants in the esthetic zone using the VST technique with xenograft alone. Pain levels were evaluated using Visual analogue scale (VAS), and pink aesthetic scores (PES) were recorded. Immediate after surgery and six months later, cone-beam computed tomography (CBCT) scans were performed to evaluate buccal bone thickness, height and changes in bone density surrounding the dental implant. **Results:** Group I exhibited significantly lower levels of pain compared to Group II. Group I (PRF) showed a slightly higher, statistically insignificant, PES compared to Group II. At the six-month mark, Group I displayed significantly greater buccal bone thickness than Group II, with an insignificant difference in buccal bone height between the two groups. Moreover, Group II exhibited higher bone density around the dental implant compared to Group I.**Conclusion:** The inclusion of PRF in the treatment enhanced osteoinductivity, promoting bone regeneration and eliminating the need for a donor site. Consequently, this approach reduced the comorbidity associated with donor site procedures, thereby decreasing patient discomfort and inconvenience.

KEYWORDS: Vestibular Socket Therapy, Xenograft, Platelet Rich Fibrin, Implant.

INTRODUCTION

Immediate implant placement is frequently regarded as the most appealing treatment option for replacing irreparable teeth in the esthetic zone[(1)]. When executed correctly, this approach can significantly reduce treatment duration and produce positive esthetic outcomes[(2)]. It's important to note, however, that immediate implantation may not be suitable for compromised extraction sockets characterized by a deficient labial bone plate, as classified under Elian's type II socket categorization[(3)].

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The use of collagen-enriched xenograft blocks to treat facial dehiscence defects without the requirement for fixation has resulted in marginal increases in buccal bone thickness and little gingival recession [4].

In 2019, Elaskary et al.[5] introduced an innovative technique called vestibular socket therapy (VST), which has shown promise. This method centers on the utilization of a slow-resorbing cortical xenogeneic bone shield to replace the deficient labial plate. Even in sockets with complete facial bone, recession remains a serious problem associated with immediate implant insertion, with roughly 20% of immediate implants developing at least a 1mm mucosal recession [6, 7].

Although the recently proposed VST technique has the potential to address several challenges, it relies on a combination of autogenous bone graft and xenograft to fill the gap between the implant surface and the labial alveolar plate. Autogenous bone grafting is widely considered the benchmark among grafting methods, but it has its constraints, including limited availability, the need for an additional surgical site, donor site complications, prolonged surgical time, and the necessity for advanced surgical expertise. Consequently, it is imperative to explore the effectiveness of VST in managing class II sockets in the esthetic zone when the graft material exclusively comprises xenogeneic bone, both with and without the inclusion of platelet-rich fibrin.

SUBJECTS AND METHODS

The present randomized controlled clinical study relies on clinical and radiographic data obtained from patients selected at the Outpatient Clinics of the Department of Oral and Maxillofacial Surgery within the Faculty of Dental Medicine at Al-Azhar University in Cairo, Egypt.

The study sample comprised 14 patients who were chosen based on the following criteria: patients with non-restorable maxillary anterior teeth and type II extraction sockets, suitable for immediate implant placement. These patients were identified among those seeking treatment at the Outpatient Clinic of Oral and Maxillofacial Surgery, Faculty of Dental Medicine, Al-Azhar University, located in Cairo, Egypt.

Inclusion criteria were type II extraction sockets in maxillary anterior teeth Good systemic health of the patient (ASA Ps I and II), presence of adjacent teeth and patient age above 18 years old.

Exclusion criteria were acute infection at the implantation site, pregnancy, heavy smokers smoke more than 10 cigarettes per day and patient with previous treatment with chemotherapy or radiotherapy.

Size calculation:

Based on the study of Elaskary et al.[8] and the G Power statistical power analysis program (version 3.1.9.4) for sample size determination[9], we determined that a sample size of n=14, divided equally into two groups of seven each, would provide sufficient statistical power to detect a significant effect size (d) of 2.17. This calculation assumed an actual power of 0.80 (80%) and a significance level of 0.05 (5%) for a two-sided hypothesis test.

Ethical considerations: (813/3029) The clinical part of this study was performed after gaining the ethical clearance from the research ethics committee and informed with consent at Faculty of Dental Medicine, Al-Azhar University.

Patients grouping:

The patients were randomly divided into two groups of seven patients each. Group I patients underwent immediate implants in the esthetic zone utilizing VST, xenograft, and PRF. In Group II, instantaneous implant insertion in the esthetic zone was performed utilizing the VST method with xenograft alone.

Surgical procedure:

The surgical procedure was carried out under local anesthesia using Articaine hydrochloride with epinephrine infiltration. The tooth was atraumatically extracted, employing a periotome to separate the gingival and periodontal ligament fibers for controlled loosening. Subsequently, forceps were utilized to extract the tooth, and the socket was meticulously curetted to eliminate any residual periodontal ligaments. The process concluded with thorough irrigation using saline solution.

Implant placement:

Following the manufacturer's guidelines, the initial drill was used with a palatal inclination to establish primary stability. After the appropriate osteotomy preparation, the implant was removed from its packaging and placed entirely within the prepared socket in a vertical orientation. It was then manually screwed into its final position. The primary stability of the implant was assessed using the Ostell device. A smart peg was inserted into the implant to measure stability, and the resulting ISQ value was recorded in the patient's chart.

Subsequently, VST was employed. A vestibular incision measuring one centimeter in length was crafted, positioned three to four millimeters below the mucogingival junction of the affected tooth. To establish a linkage between the socket opening and this vestibular incision, a subperiosteal tunnel was meticulously fashioned using a micro periosteal elevator and a periotome. A pliable cortical membrane shield was moistened, trimmed, and securely affixed through the vestibular access incision, extending downwards by 1.0 millimeter below the socket opening. Subsequently, it was firmly secured to the underlying apical bone using membrane tacks.

PRF Preparation:

In this study, patients' blood samples were collected from seven healthy volunteers. Blood samples were drawn into 10-mL glass-coated plastic tubes (Vacutainer; Becton Dickinson, Franklin Lakes, NJ) without any anticoagulants. These samples were promptly centrifuged at 3000 rpm for a duration of 10 minutes. As a result, the tube naturally formed three distinct layers: a layer of RBCs settled at the bottom, acellular plasma floating on top, and in between these layers, a PRF clot formed. It was simple to separate the fibrin clot from the bottom section of the centrifuged blood. Using sterile dry gauze, the PRF clot was then gently squeezed into a membrane for use in following investigations.

In Group I, the space between the implant and the shield or labial plate was filled with both xenograft and PRF, and the incision was subsequently sealed using polypropylene sutures.

In Group II, the space between the implant and the shield or labial plate was filled with xenograft alone.

The sutures were employed to securely close the incision using polypropylene 4/0 sutures. We meticulously fashioned and prepared customized healing abutments, ensuring they were thoroughly cleaned and disinfected. These abutments were then gently inserted using manual torque to provide sufficient support to the soft tissues while preserving the integrity of the gingival structure. These specially crafted healing abutments were designed with the purpose of creating an enclosed chamber, which served as a protective barrier for the bone graft. This chamber was constructed using a temporary abutment (PEEK Temporary Cylinder, Biomate) and a composite resin (Filtek Supreme Ultra Flowable Restorative, 3M, St. Paul, MN, USA).

The sutures were removed ten days following the surgery, and the final crowns (BruxZir full anatomical zirconia, Glidewell, Newport Beach, CA, USA) were cemented in place after a waiting period of six months. **Figure 1,a,b,c,d**

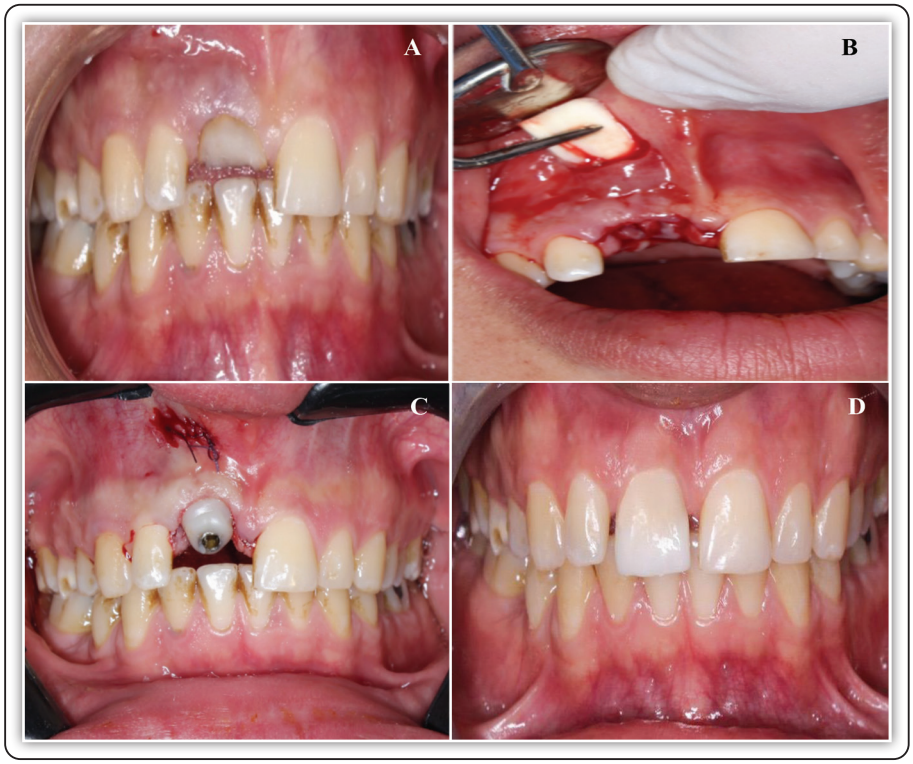

FIG (1) Showing (A)Preoperative situation (B) xenogenic cortical lamina (C) Custom made healing abutment (D) final prosthesis

Post-operative care:

During the initial 24 hours after the procedure, cold compresses were applied. From the following day and throughout the next week, a warm mouthwash containing Povidone iodine was used every six hours. Antibiotics in the form of amoxicillin (875mg) combined with Clavulanic acid (125mg) tablets were administered twice daily for a duration of seven days. Additionally, a nonsteroidal anti-inflammatory drug, specifically potassium diclofenac in 50mg tablets, was taken three times daily for five days to manage pain and inflammation.

Post-operative follow-up:

1. Clinical evaluations:

Pain: It has been evaluated using VAS on the first day, third day and one week post operatively [10].

The Pink Esthetic Score (PES) was assessed at the time of crown placement, specifically at the six-month post-operative [11]. PES relies on seven distinct criteria: the mesial papilla, distal papilla, soft tissue level, soft tissue contour, alveolar process deficiency, soft tissue color, and soft tissue texture. This evaluation employs a rating system ranging from 0 to 2, where 0 represents the lowest score and 2 signifies the highest. The maximum achievable score is 14, indicating a complete alignment of the peri-implant soft tissue with that of the reference tooth. While examining the presence or absence of mesial and distal papilla, all other parameters were compared to reference tooth. This reference tooth corresponded to the anterior region, or an adjacent tooth in the premolar area.

Radiographic evaluations:

A CBCT system was utilized to evaluate bone quality in this study. The imaging system employed was the Planmeca Pro-face model, which had a field of view measuring 10 cm x 10 cm. To control patient radiation exposure, specific exposure parameters were adjusted. These included a tube voltage (Kvp) of 90 (in pulsed mode), a tube current of 12.5 mA, and a voxel size of 150 microns. The reconstruction process took approximately 1 minute

and 20 seconds. Our navigation software enabled us to assess bone quality at each implant site.

The reconstructed 3D images obtained from the CBCT scans were reviewed and analyzed using Romexis software (Planmeca Romexis 5.3.4.39,6, Helsinki, Finland), which was integrated into the CBCT device. To establish a reference point, a line was drawn from the crest of the bone to the implant apex. Gray values of the bone surrounding each implant were then measured, with a sagittal view along the middle of the implant used for this purpose. To determine bone density in Hounsfield Units (H.U.), a standard rectangular shape was delineated both anterior and posterior to the implant. The center of the implant in the coronal, sagittal, and axial views served as the reference point for image registration. Figure 2,a,b,c.

Statistical analysis

Data was gathered, subjected to thorough examination, revised as necessary, and subsequently structured into tables and figures utilizing Microsoft Excel. The data was then input into a computer and subjected to analysis employing IBM SPSS software version 26.0 (Armonk, NY: IBM Corp). To assess the normality of the data distribution, the Kolmogorov-Smirnov test was utilized. Descriptive statistics, such as the range (minimum and maximum values), mean, standard deviation, and median, were employed to summarize the quantitative data. The statistical significance of the findings was determined at 0.05.

RESULTS

Visual Analogue Scale (VAS)

On day 1, VAS scores were insignificantly different between the two groups (p=0.363). However, on day 3 and at the one-week mark, there were notable differences in VAS scores between the studied groups (All p-value <0.05). Specifically, Group I (PRF) exhibited significantly less pain compared to Group II.

Pink Esthetic Score (PES)

All patients underwent an assessment using the PES, a tool that assesses seven different factors: mesial papilla, distal papilla, soft tissue level, soft tissue shape, alveolar process deficit, soft tissue color, and soft tissue texture. Each of these aspects received a score ranging from 0 to 2, with 0 indicating the least favorable outcome and 2 signifying the most favorable outcome. Thus, a score of 14 indicated that the peri-implant soft tissues were in excellent condition. Soft tissues with a score of 8 were considered clinically acceptable, while those with a score of 12 or higher were considered nearly ideal.

There was no statistically significant distinction in PES scores between the two groups at the 6-month mark (P-value > 0.05).

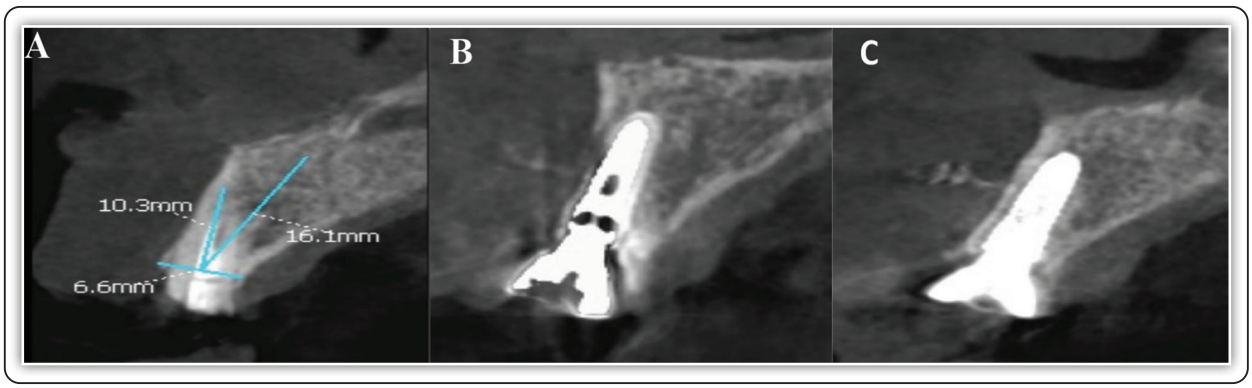

FIG (2) Showing group I (A) Preoperative CBCT (B) Immediate postoperative CBCT (C)6months postoperative CBCT

TABLE (1) Comparison of both groups according to VAS .

	Group I (PRF)		Group II		t	p
	Mean	SD	Mean	SD		
1 day	4.83	0.40	5.16	0.75	-0.953	0.363
3 days	2.16	0.40	3.00	0.63	-2.712	0.022*
1 week	0.33	0.51	1.33	0.51	-3.354	0.007*

TABLE (2) Comparison of both groups according to PES after 6 months.

	Group I (PRF)		Group II		p
	Mean	SD	Mean	SD	
Mesial papillae	1.71	0.48	1.57	0.53	0.611
Distal papillae	1.86	0.37	1.71	0.48	0.552
Contour	1.71	0.48	1.57	0.53	0.611
Soft tissue level	1.57	0.78	1.43	0.78	0.740
Alveolar process	1.71	0.48	1.57	0.53	0.611
Color	1.57	0.53	1.43	0.53	0.626
Texture	1.71	0.48	1.57	0.53	0.611
Overall, PES score	12.00	3.10	10.85	3.62	0.539

Radiographic

Buccal bone thickness

Buccal bone thickness was insignificantly different between the two groups at various points: Before (Apical, Middle, Cervical) and Immediate (Apical, Middle, Cervical) (All P-values > 0.05).

However, after a period of six months, a significant difference emerged between the two groups in relation to buccal bone thickness at the Apical point (p=0.003). In contrast, buccal bone thickness was insignificantly different between the studied groups at the Middle and Cervical points at the six-month mark (All P-values > 0.05).

Furthermore, when assessing the gain in millimeters at the immediate stage, there was no significant difference between the two groups in terms of buccal bone gain. However, after six months, a significant difference in buccal bone gain at the Apical point (p=0.008) was observed, while no significant difference was noted at the Middle and Cervical points (p=0.128 and p=1.000, respectively).

TABLE (3) Comparison between the studied groups according to buccal bone thickness.

		Group 1 (PRF)		Group 2		p
		Mean	SD	Mean	SD	
Before	Apical	1.75	0.27	1.90	0.21	0.319
	Middle	0.45	0.16	0.40	0.00	0.473
	Cervical	0.40	0.21	0.30	0.10	0.341
Immediate	Apical	2.20	0.43	3.05	0.93	0.071
	Middle	0.75	0.16	1.25	0.71	0.125
	Cervical	1.05	0.16	0.85	0.49	0.368
6 months	Apical	3.45	0.82	2.10	0.10	0.003
	Middle	1.45	0.71	1.00	0.21	0.170
	Cervical	1.30	0.21	1.20	.10	0.341
Gain in mm at immediate	Apical	0.45	0.16	1.15	1.15	0.171
	Middle	0.30	0.00	0.85	0.71	0.088
	Cervical	0.65	.05	0.55	0.38	0.541
Gain in mm at 6 months	Apical	1.70	1.09	0.20	0.10	0.008
	Middle	1.00	0.54	0.60	0.21	0.128
	Cervical	0.90	0.00	0.90	0.00	1.000
Gain in mm at immediate	Apical	0.45	0.16	1.15	1.15	0.171
	Middle	0.30	0.00	0.85	0.71	0.088
	Cervical	0.65	.05477	0.55	0.38	0.541
Gain in mm at 6 months	Apical	1.70	1.09	0.20	0.10	0.008
	Middle	1.00	0.54	0.60	0.21	0.128
	Cervical	0.90	0.00	0.90	0.00	1.000

t-test: independent t-test p: p value between groups

Buccal bone height

A significant difference was observed between the two groups with regard to buccal bone height at the Before, Immediate, and 6-month time points (p≤0.001*).

Moreover, when assessing the gain in millimeters at the immediate stage, buccal bone height was insignificantly different between the studied groups (p=1.000). Similarly, at the 6-month follow-up, buccal bone height was insignificantly different between the studied groups (p=0.064).

TABLE (4) Comparison between the studied groups according to buccal bone height

		Group1 (PRF)		Group2		p
		Mean	SD	Mean	SD	
Before	**Before**	14.10	0.65	11.00	0.54	≤0.001*
	Immediate	14.05	0.71	10.95	0.60	≤0.001*
	6 months	13.85	0.71	10.05	0.27	≤0.001*
Gain in mm at immediate		0.05	0.05	0.05	0.05	1.000
Gain in mm at 6 months		0.25	0.05	0.95	0.88	0.064

t-test: independent t-test p: p value between groups

Bone density

No statistically significant difference was observed between the two groups in terms of buccal bone height at the Before, Immediate, and 6-month intervals (p=0.909, 0.352, 0.062, respectively). However, when analyzing the gain in millimeters at the immediate stage, a significant difference emerged between the two groups in relation to bone density (p=0.002*). Specifically, Group 2 exhibited higher bone density compared to Group 1 (PRF).

In contrast, at the 6-month follow-up, bone density was insignificantly different between the two groups (p=0.448).

TABLE (5) Comparison between the studied groups according to bone density.

	Group1 (PRF)		Group2		p
	Mean	SD	Mean	SD	
Before	529.50	29.02	521.50	163.76	0.909
Immediate	666.50	33.41	719.50	128.71	0.352
6 months	833.50	41.07	899.50	65.17	0.062
Gain in mm at immediate	137.00	4.38	198.00	35.05	0.002*
Gain in mm at 6 months	304.00	12.04	378.00	228.94	0.448

t-test: independent t-test p: p value between groups

DISCUSSION

Tooth extraction can result in significant natural alveolar bone loss, particularly affecting bundle bone loss and leading to changes in alveolar ridge dimensions, as highlighted in references [12,13]. This bone loss can present challenges for functional and aesthetic dental restorations, including the use of dental implants[14]. Furthermore, thin labial bone plates are more susceptible to acute post-extraction bone loss, often attributed to factors such as chronic inflammation, vertical root fractures, periodontal issues, or prior trauma before extraction. Standard extraction techniques, including mucoperiosteal flap reflection, can exacerbate alveolar bone loss in these cases [15, 16].

Therefore, it is crucial to minimize trauma during the extraction of hopeless teeth to preserve the adjacent hard and soft tissues, significantly influencing treatment planning, outcomes, and prognosis[17]. Consequently, Elaskary developed VST to address various freshly extracted sockets with alveolar deficiencies, such as thin or deficient facial plates with active infections. This approach follows a protocol that involves restoring freshly extracted infected sockets while simultaneously placing implants [8].

Nonetheless, it's important to recognize that the VST technique, as developed by Elaskary [5], comes with certain limitations and challenges. Primarily, VST typically requires the use of autogenous bone, which constitutes 75% of the graft material and necessitates a separate surgical procedure. This can pose difficulties in certain situations. Hence, in our present study, we opted for 100% xenograft instead of autogenous bone.

. When the buccal bone thickness measures less than 1 mm, the risk of implant exposure and failure significantly increases. VST plays a pivotal role in buccal bone preservation by avoiding the need for flap elevation, which can potentially cause trauma and inflammation to the periosteum and blood supply [18, 19].

In our current study, the data at the 6-month mark revealed that Group I exhibited notably greater buccal bone thickness at the Apical level compared to Group II. This difference can be attributed to one of the advantageous aspects of VST, which lies in its ability to maintain the crucial buccal bone thickness necessary for achieving favorable esthetic outcomes in implant therapy. Additionally, VST safeguards the buccal bone from infection and pressure by employing a PRF membrane with inherent antibacterial and anti-inflammatory properties. Furthermore, PRF aids in wound healing and bone regeneration through the release of growth factors and cytokines[20].

Elaskary et al.[18] evaluated the placement of implants in compromised freshly extracted sockets in the esthetic zone using VST. They observed a significant increase in bone thickness at the middle and crestal thirds, further supporting the potential benefits of this technique.

In our study, bone thickness varied at different levels: 1.30 mm at the cervical level, 1.45 mm at the mid-implant level, and 3.45 mm at the apical level. Elaskary et al. [18] reported a mean labial bone thickness of 1.72 mm at the crestal level, which increased to 2.18 mm at the mid-implant level after one year. Assaf et al. [21] found a mean buccal bone thickness of 2.38 mm, 1 mm subcrestally, after one year, using collagen-enriched xenograft blocks. Meijer et al. [4] reported a thinner labial bone thickness of 1.01 (0.45) mm at the crestal level, possibly due to higher autogenous graft resorption. At the 6-month mark, there was no significant difference in buccal bone height between the groups, but Elaskary et al. [18] observed an increase in buccal bone height in their study. Group 2 in our study exhibited higher bone density, possibly because PRF occupied space, reducing bone graft density and resulting in denser bone. The observation of high density at three months, becoming similar at six months, supports this hypothesis.

Furthermore, Işık et al. [22] found that PRF-enriched bovine-derived xenograft yielded more vital mineralized tissue and less non-mineralized tissue than bovine-derived xenograft alone in critical bone defects in rabbits. Maia et al. [23] demonstrated that the combination of PRF with xenograft increased bone neoformation in critical bone defects in rabbits when compared to the use of xenograft alone. Conversely, Ali and Abd-El hakam [24] reported that PRF had no discernible impact on the maturation of deproteinized bovine bone in maxillary sinus augmentation.

In our current study, the findings indicate that Group I experienced significantly less pain compared to Group II. VST, by utilizing a vestibular incision, minimizes damage to the buccal tissue, thereby reducing postoperative discomfort and swelling.

In our study, the esthetic outcome using our technique was rated at 12.00, with no significant difference observed between the two groups in PES after 6 months. Group I had a slightly higher PES than Group II, but this difference lacked statistical significance. Notably, Elaskary et al. reported a mean total Pink Esthetic Score of 12.63, which closely aligns with scores from other studies

like Noelken et al.[25] (mean = 12.5) and Sicilia-Felechosa et al. [26] (mean = 12.43). Noelken et al. [25] attributed their high esthetic score to their specific flap technique and immediate temporization, which helped maintain the original socket contours.

In this study, Biomate implants were utilized, which feature a proprietary PDL(precision Dimension laser) Laser surface treatment. This treatment creates a distinctive microchannel structure with 3D pores on the implant surface, facilitating rapid cell adhesion, angiogenesis, and accelerated initial calcification. The PDL Laser surface treatment contributes to the maintenance and augmentation of primary stability.

CONCLUSION

In conclusion, the integration of immediate implant placement with Vestibular Socket Therapy demonstrates favorable outcomes in radiographic, aesthetic, and periodontal aspects, all while streamlining treatment duration and reducing the necessity for multiple surgical interventions. An instrumental component in the success of VST lies in the utilization of a combination of PRF and xenograft. PRF enhances osteoinductivity, thereby promoting bone regeneration and obviating the requirement for a donor site. Consequently, this approach mitigates the associated comorbidities, offering patients a reduction in both pain and inconvenience.

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