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Opportunity of the Effect of Injectable Platelet Rich Fibrin (I-PRF) Mixed with Bone Graft on the Correlation Between Dental Implant Stability and Alveolar Ridge Width. A Clinical Comparative Study

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Abstract

The potential impact of injectable platelet-rich fibrin (I-PRF) combined with bone graft as a guided bone regeneration on the relationship between dental implant stability, alveolar ridge width, and dental implant dimension.

Materials and methods: The present prospective comparative study was registered at ClinicalTrials.gov (ID number: NCT05427643). A total of 13 patients aged 18-65 years (11 females and 2 males) presented with missing teeth in either the maxilla or the mandible or both and met the eligibility criteria and enrolled in this study treated with 40 dental implants. These cases were allocated into two groups, control group in which the implants were placed without I-PRF and a study group (advanced cases with narrow alveolar ridge) in which implants were installed with I-PRF mixed with synthetic bone graft at the dehiscence sites around the implants. **22 (55%)** dental implants were inserted in patients with alveolar bone width of < **3.5** mm and **18 (45%)** dental implants were inserted in ridge with ≥ **3.5** mm. The primary stability was measured at the time of surgery and Secondary stability was measured 24 weeks after dental implant installation with Anycheck device in implant stability test (IST) values. **Results:** Twenty dental implants were installed in each study group. According to the results obtained in this study, there was significant difference between primary stability (**69.96±8.5** vs **74.50±4.3**) of both groups and secondary stability (**69.96±8.5** vs **76.32±6.5**) values of group A with bone width of ≥ **3.5** mm and dental implant dimension **4.1** mm. **Conclusion:** The addition of I-PRF with bone graft for augmentation of dehiscence and fenestration peri-implant defects with simultaneous implant placement results in 100% survival rate with statistical differences in implant secondary stability between study groups. However, the results were clinically irrelevant.

Introduction:

Dimensional changes that occur following tooth extraction are unavoidable due to the bundle bone's dependence on teeth, as well as other variables such a lack of functional stimulation, a lack of vascular blood supply since the periodontal ligament is absent, and genetic factors (1,2). Alveolar ridge abnormalities are categorized according to their severity and morphology. To facilitate physician communication regarding the choice and sequencing of reconstructive treatments intended to address these flaws, a classification for alveolar ridge deficiencies has been devised. Hard and soft tissues must be present in sufficient quantity and of acceptable quality to meet the requirements of implant dentistry. Dental implants (DI) are typically placed by physicians in anatomically unfavorable places compared to the amount of available bone in order to produce the best restorative results (3). A dehiscence or fenestration defect, which exposes a portion of the implant body, may occur as a result of implant placement if a horizontal defect is present. Dehiscence or fenestration may reduce the success of implants or raise the likelihood of failure (4). The need for reliable regeneration treatment has necessitated the development of techniques and materials. Regeneration is the process of completely regaining both a part's structure and function after it has been lost or damaged (3). The treatment of horizontal bone deficiencies with guided bone regeneration (GBR) is well established. This procedure allows for the filling of a space maintained by either resorbable or non-resorbable barrier membranes with bone, allowing for the regeneration of bone tissue. It can be combined with a number of bone graft alternatives to treat alveolar bone defects around implants in areas where there is not enough bone (5). In order to improve the performance of bone graft replacements in bone augmentation and decrease postoperative bone resorption, biomaterials made from centrifuging patients' own blood have recently been used (5,6). Platelet rich fibrin (PRF), a biomaterial derived from human blood, is a component of a platelet concentrate obtained through centrifugation. It is often utilized for tissue regeneration, post-operative recovery, and rehabilitation in both medicine and dentistry. Fibrin plasma's hemostatic, adhesion, and healing properties have helped thoracic, cardiovascular, neurological, ophthalmic, reconstructive, and dental treatments (7). In a more recent advancement, Choukroun and Ghanaati (2018) produced an injectable form of a new hemoderivative family and proposed a way to produce a liquid platelet rich fibrin (I-PRF) that could be administered prior to gelation. Similar to advanced platelet rich fibrin, fresh blood is softly centrifuged for a brief period of time without the addition of an anticoagulant (8).

Materials and Methods

Study design:

This clinical prospective comparative study design with double blindness (the assessor and the statistician) included a total of 13 Iraqi patients aged 18-65 years (11 females and 2 males) presented with missing teeth in either the maxilla or the mandible or both and met the eligibility criteria and enrolled in this study treated with 40 DI, (sample size was measured according to G* power 3.1.9.7 sample size calculation with effect size 0.5).

These cases were allocated into two groups, **control group (straightforward cases)** in which the implants were placed without I-PRF and a **study group (advanced cases with narrow alveolar ridge)** in which implants were installed with I-PRF mixed with synthetic bone graft to cover the dehiscence sites around dental implants. For both, the surgical site was examined for the hard and soft tissue clinically and radiographically (OPG and CBCT) by the operator.

Ethical statement:

The study protocol was approved by the Research Ethics Committee of the College of Dentistry, University of Baghdad (protocol number: 394121) and was registered at ClinicalTrials.gov (ID number: NCT05427643).

Clinical procedure:

All procedures were carried out utilizing Septodent® Lidocaine 2% with epinephrine (1:80,000) local anesthetic in the designated surgical field. To reveal the crestal and buccal alveolar bone, an extensive three-sided or limited full thickness mucoperiosteal flap was reflected. Before preparing the implant bed, the width of the alveolar ridge was assessed intraoperatively by a bone caliper, Fig (1).

Implants were installed using a surgical micro-motor handpiece with a torque of 35 N/cm and a speed of 35 rpm using a dental implant system (NucleOSS™T6, Turkey) and sequential drilling technique with drills of increasing diameters in accordance with manufacturer's recommendations at 600-800 revolutions per minute (rpm). With the conventional healing abutment measuring 4 mm in height and 5 mm in diameter, the primary stability of the implant was assessed immediately after implant placement using the AnyCheck device, Fig (2). The placement of the DI caused a dehiscence defect in the buccal or labial cortical plate in the study group. Injectable PRF was produced by drawing 5 ml of autologous blood from the cubital fossa (forearm) superficial veins using a 5 C.C. sterile disposable syringe in order to cover that deficit. The entire volume of blood was transferred to a glass test tube, and it was immediately centrifuged at room temperature for 3 minutes (min) at 700 rpm, Fig (3). A liquid form I-PRF was formed on the top of the tube and the red corpuscles at the bottom. The I-PRF is then aspirated using 3 C.C. sterile disposable syringe, Fig (4). The aspirated liquid was mixed with the non-autogenous synthetic bone graft (maxresorb®, botiss biomaterials GmbH©, Germany) in a mixing jar using a condenser and then left for about 10-15 min to form a sticky mixture with the bone graft, Fig (5).

Finally, the cover screw was placed with the aid of a hex driver then the I-PRF mixture is applied on the defect site around DI. Wound closure was accomplished utilizing interrupted 3/0 braided black silk sutures, Fig (6).

Follow up

The second stage DI uncoverage surgery was accomplished at the 24-week follow-up visit, secondary stability was measured with the same manner of the primary one.

Statistical analysis

The statistical analyses were performed using IBM SSPS (version 24). Shapiro–Wilk test was performed to test normality of the distribution, the data were not normally distributed. The changes of IST, over time were compared within each group using Wilcoxine signed -rank test. Mann Whitney U test to determine the significant difference between two groups only depending on mean rank in each test. **$P \leq 0.05$** was considered to be statistically significant.

Results

Regarding the jaw variable, the statistical analysis demonstrates that the larger number of DI inserted in the mandible was **(67.5%)** while **(32.5%)** of them were introduced in the maxilla. The number of DI located in the ischemic zone was the prominent included **23 (57.5%)**, as illustrated in Table (1).

Allocation of data according to alveolar ridge width and implant dimension

Table (2) illustrates that the highest number of DI 22 (55%) was inserted in patients with alveolar bone width of < 3.5 mm. While the research data showed that DI diameter 4.1 mm were the dominant used in 26 (65%) of DI.

Statistical analysis of implant stability correlation with jaw and side:

Table (3) illustrates that there was a statistical significant effect of the jaw on secondary stability results between and within each groups (**75.43±6.7** vs **80.16±3.4**). Regarding the side, there was significant change in primary satbility between two groups in the right side only (**69.54±8.3** vs **71.67±3.9**).

The effect of the alveolar bone width and DI dimension on implant stability:

According to the results obtained in this study, Table (4) shows significant difference between primary stability (T1) (**69.96±8.5** vs **74.50±4.3**) of both groups and secondary stablility (**69.96±8.5** vs **76.32±6.5**) (T1, T2) values of group A with bone width of ≥ **3.5** mm and DI dimension **4.1** mm. Moreover, there was no statistical change in IST values with other variables. In the present study, the patients included were not subjected to any intraoperative complication. Regarding postoperative complications there was only **3** out of **13** patients presented with transient numbness in the mandible that resolved completely after 8 weeks.

Survival Rate of DI

The total number of DI installed in this study was **40**. All of them were survived after 24 weeks.

Discussion

The present research aimed to study the effect of I-PRF mixed with particulate bone graft as a simultaneous horizontal ridge augmentation utilized for narrow alveolar ridges that has a width of less than 6 mm on secondary dental implant stability and compare the results with straightforward cases. The study included a total of 13 Iraqi patients aged 18-65 years (11 females and 2 males, this predominance was also observed in other Iraqi clinical studies conducted at the College of Dentistry-University of Baghdad (9,10). There was a statistical significant effect of the mandible on secondary stability results between each group (75.43±6.7 vs 80.16±3.4), with statistical difference between primary and secondary stability in the study group B (74.33±4.6 vs 80.16±3.4), this result is in accordance with the study accomplished by **Güvenç et al., (2022)** who investigated the effect of I-PRF on implant stability in mandibular edentulous area and found that I-PRF had positive effect on implant stability and the ISQ values were higher in the study group (11).

Regarding the side, there was significant change in primary stability between two groups with higher IST values in the right side only, it can be attributed to the bias in sample distribution between both groups for this side as (5 out of 6) implants in the mandible for group B and (8 out of 11) for group A. One important point to be mentioned is that according to the IST device manufacturer, which is based on many studies, the IST values are divided into three levels as mentioned by **Guller. 2008**, who's stated that the analysis of the data illustrated and confirmed not all the statistically significant results essentially being clinically relevant. Accordingly, although there was a statistical difference between groups but clinically irrelevant since there is no change in the stability from one category to another in the both groups (12).

Association between implant diameter, alveolar ridge width and IST values:

The dental implant diameter of 4.1 mm that has been inserted in the alveolar ridge width of ≥ 3.5 mm had statistical significant effect on secondary stability for group A. Several studies showed that DI in the mandible are often reported to achieve better primary implant stability, In contrast, maxillary implants resulted in higher implant stability increases between primary and secondary measurements, which probably resulted from the lower primary implant stability values of maxillary implants, additionally, healing time is significantly associated with higher ISQ values, thus there is a positive associations between primary implant stability and implant diameter, implant length, and localization (13). Accordingly, these findings is in accordance with the results provided by this research as (DI 14 out of 16 installed in the mandible for group A, versus 2 out of 2 for group B).

In a conclusion, Primary and secondary implant stability can be successfully achieved with horizontal ridge augmentation in alveolar ridge widths less than 3.5 mm without any postoperative complications, and the statistical difference seen in this research according to study variables was caused by the bias in sample distribution between the maxillary and mandibular arch, with no clinical relevance attributed to the addition of I-PRF.

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Competing Interests
The authors have no relevant financial or non-financial interests to disclose.

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Author Contributions
All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by [Sora Salam] and [Thair A. Lateef Hassen]. The first draft of the manuscript was written by [Sora Salam] and both authors commented on previous versions of the manuscript. Both authors read and approved the final manuscript.

Consent to participate

Informed consent was obtained from all individual participants included in the study.

Consent to publish

The authors affirm that human research participants provided informed consent for publication of the images in Figures 1a, 1b, 2a, 2b, 3a, 3b, 6a, 6b, and 6c.

Data Availability:

Data availability within the article or its supplementary materials.

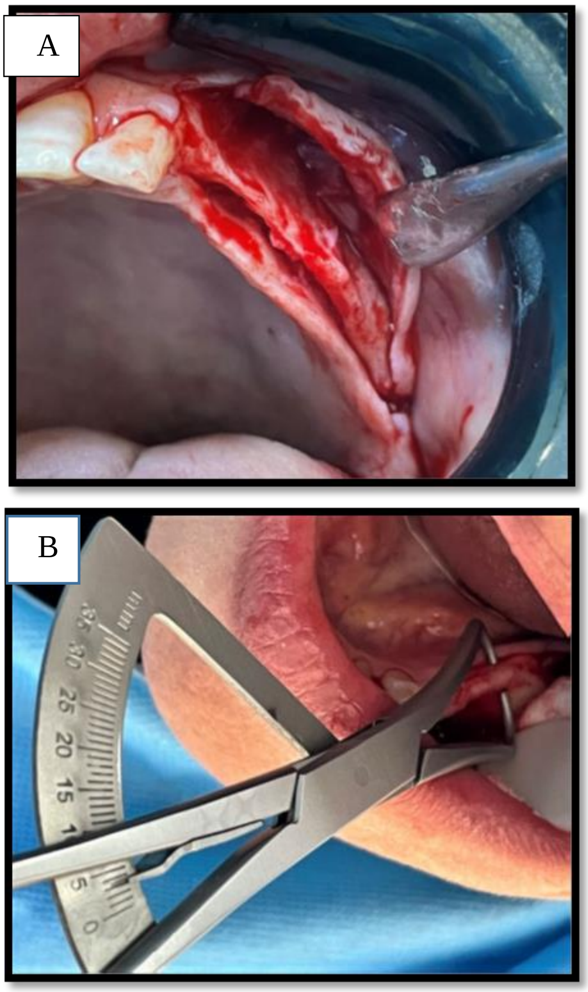

Fig (1): (A) An extensive three-sided flap. (B) Alveolar ridge width (3.5 mm) measured before

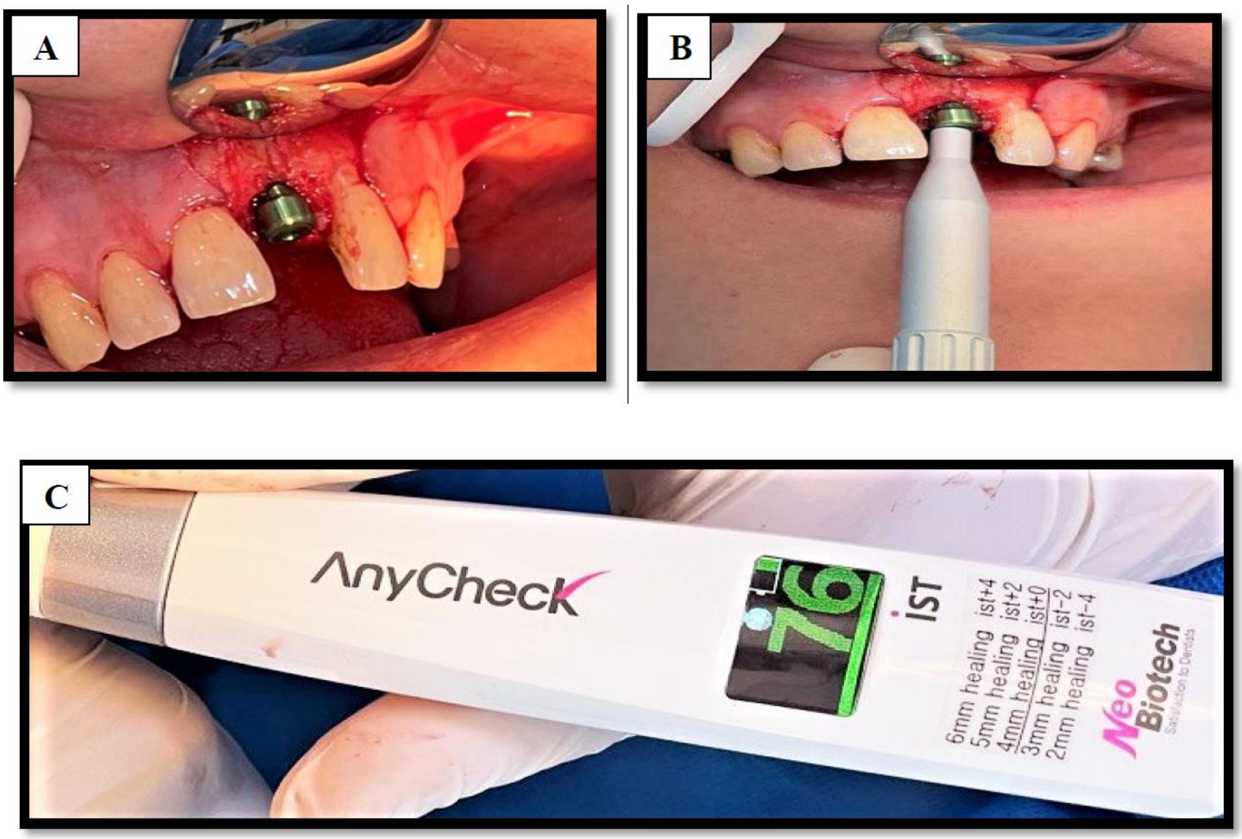

Fig (2): (A) A standard healing abutment screwed into the implant fixture. **(B)** Primary implant stability measurement performed using AnyCheck device. **(C)** The IST value.

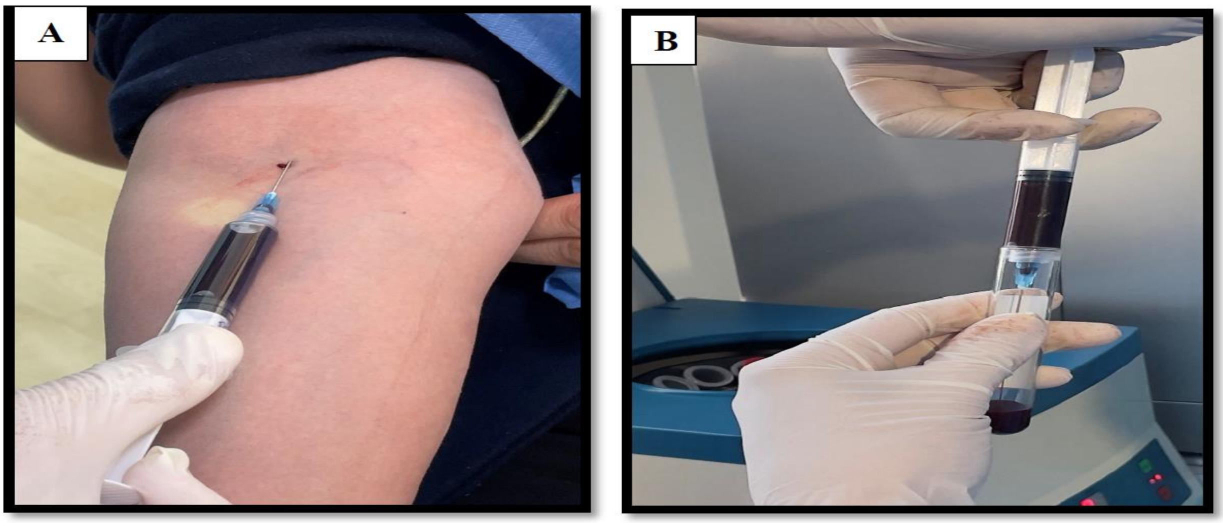

Figure (3): (A) collection of autologous blood. **(B)** Transferring of the blood into glass test tube for immediate centrifugation.

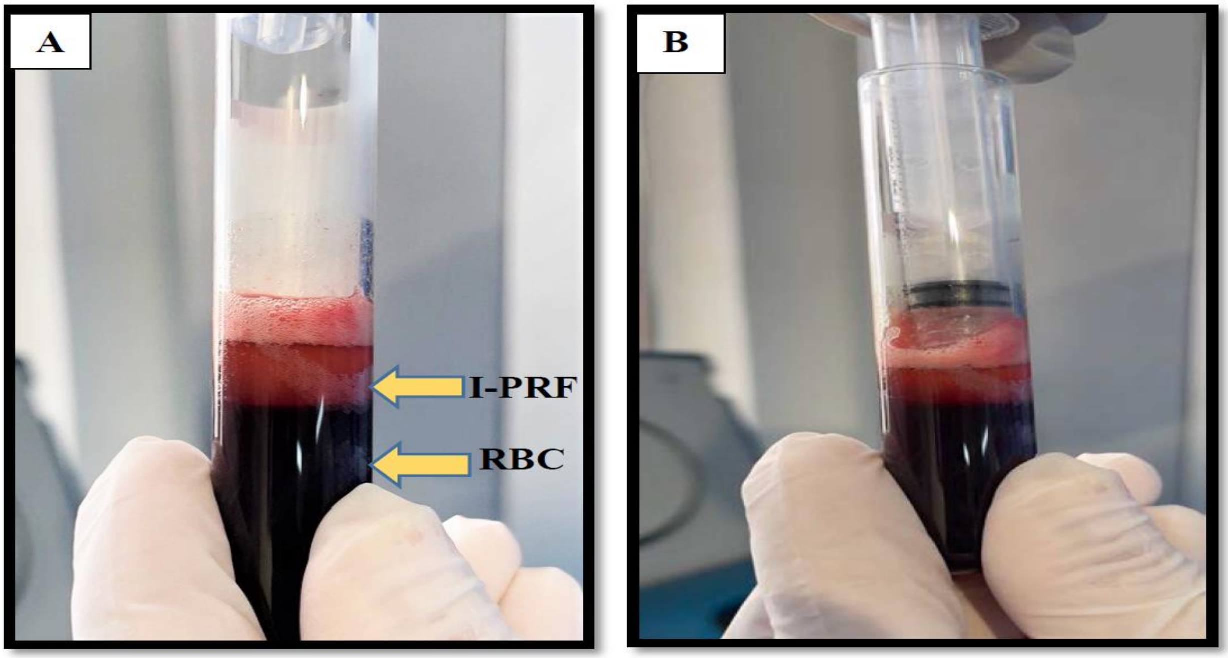

Fig (4): (A) The I-PRF on the top of the tube immediately after centrifugation.

(B) Aspiration of I-PRF by disposable syringe

Fig (5): The I-PRF polymerized with the bone graft.

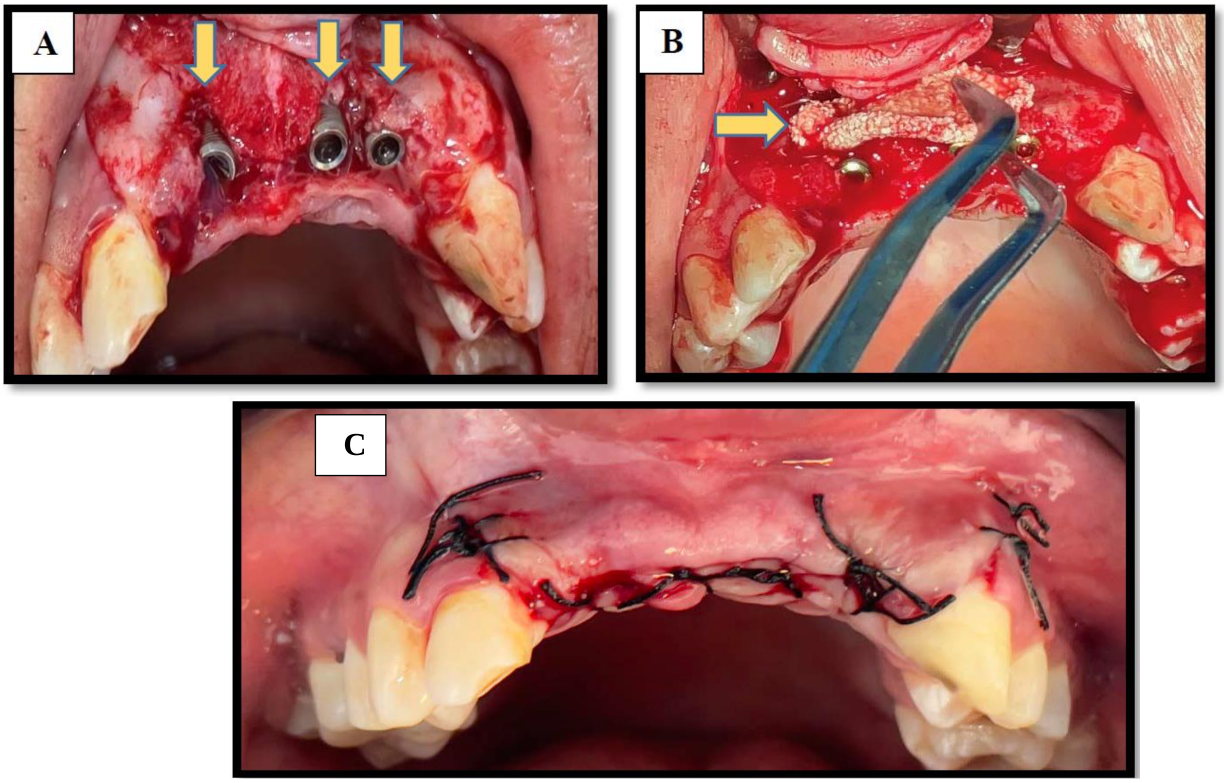

Fig (6): (A) Dehiscence of bone around DI. (B) Dehiscent site coverage by the mixture of I-PRF with bone graft. (C) Wound closure.

Table (1): Descriptive statistics of DI regarding jaw, side and FIZ.

Jaw			
	Control Group	**Study Group**	**Total**
	DI No. (%)	**DI No. (%)**	**DI No. (%)**
Maxilla	5 (12.5)	8 (20)	**13 (32.5)**
Mandible	15 (37.5)	12 (30)	**27 (67.5)**
Side			
Right	11(27.5)	6 (15)	**17 (42.5)**
Left	9 (22.5)	14 (35)	**23 (57.5)**
Functional Implant Zone			
Traumatic	2 (5)	5 (12.5)	**7 (17.5)**
Sinus	1(2.5)	3 (7.5)	**4 (10)**
Inter-foraminal	3 (7.5)	3 (7.5)	**6 (15)**
Ischemic	14 (35)	9 (22.5)	**23 (57.5)**

Table (2): Dental implants distribution according to the bone width and implant dimension (diameter and length)

Ridge Width			
	Control Group	**Study Group**	**Total**
	DI No. (%)	**DI No. (%)**	**DI No. (%)**
≥ 3.5	14 (35)	4 (10)	**18 (45)**
< 3.5	6 (15)	16 (40)	**22 (55)**
Implant Dimension			
3.5 (8,10,12,14)	4 (10)	10 (25)	**14 (35)**
4.1 (8,10,12,14)	16 (40)	10 (25)	**26 (65)**

Table (3): Dental implant stability in correlation with jaw and side.

Implant Stability										
Jaw	**Maxilla**					**Mandible**				
	T1	**P1**	**T2**	**P2**	**P**	**T1**	**P1**	**T2**	**P2**	**P**
A	71.80±11.9	**0.94**	75.50±6.0	**0.77**	**0.69**	70.23±7.8	**0.19**	75.43±6.7	**0.02**	**0.21**
B	71.43±5.4		73.62±7.5		**0.67**	74.33±4.6		80.16±3.4		**0.003**
Side	**Right**					**Left**				
A	69.54±8.3	**0.05**	75.27±7.8	**0.84**	**0.02**	71.94±9.4	**0.75**	75.67±4.7	**0.13**	**0.37**
B	71.67±3.9		77.17±8.1		**0.06**	73.82±5.4		77.71±7.2		**0.08**

T1: Primary stability**, T2:** secondary stability**, P1:** probability value of primary stability changes between groups, **P2**: probability value of secondary stability between groups, **P:** probability value within each group, **SD:** Standard deviation, **DI:** dental implant, Sig: significant.
Mann Whitney U test: test the significant difference between two groups
Wilcoxine signed -rank test: measure the statistical difference within each group

Table (4): Implant stability changes concerning bone width and implant dimension.

	Implant Stability									
	< 3.5 Bone width					≥ 3.5				
	T1	**P1**	**T2**	**P2**	**P**	**T1**	**P**	**T2**	**P2**	**P**
A	72.2±9.5	**0.66**	73.40±6.2	**0.19**	**0.40**	69.96±8.5	**0.05**	76.32±6.5	0.28	**0.03**
B	72.84±5.2		77.15±6.6		**0.21**	74.50±4.3		79.12±4.1		**0.14**
Dimension	**3.5 (8,10,12,14) mm**					**4.1(8,10,12,14) mm**				
A	74.50±10.3	**0.94**	73.50±6.5	**0.20**	**0.75**	69.65±8.3	**0.04**	75.93±6.5	0.24	**0.02**
B	72.12±6.2		79.75±3.4		**0.06**	73.43±4.9		77.00±6.7		**0.40**

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