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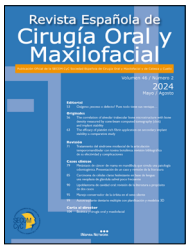

Original

The efficacy of platelet rich fibrin application on secondary implant stability: a comparative study

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ABSTRACT

Background: The hypothesis of this study was based on the concept of using platelet rich fibrin to improve implant stability by accelerate bone formation and osseointegration. Preparation of platelet-rich fibrin is a simple, low cost and minimally invasive method to obtain a natural concentration of autologous growth factors that is widely used in different fields of medicine to accelerate soft and hard tissue healing.

Aim: This study aimed to evaluate the effect of local application of platelet-rich fibrin on implants stability and determine the effect of other factors such as implant dimensions and jaw in which implant installed on implant stability.

Patients and methods: This clinical prospective comparative study was conducted at the Maxillofacial Surgery Department of Al-Yarmouk Teaching Hospital. A total of 12 Iraqi patients aged ≥ 18 years with a mean of 46.25 years (9 females and 3 males) met the eligibility criteria and enrolled in this study treated with 40 dental implants. These cases were allocated into two groups, group A (straightforward cases in which the implants were placed without platelet-rich fibrin) and group B (straightforward cases in which implants were placed with platelet-rich fibrin). The primary stability was measured at the time of surgery and the secondary one was measured 16 weeks after implant installation with Anycheck device.

Results: Twenty dental implants were installed in each study group. The average primary implant stability test value in group A & B was (63.00) and (63.85), respectively with no statistical significance. The average secondary implant stability test values 16 weeks after implant placement were found to be (69.05) and (70.00) for group A & B respectively, also with no statistical difference between the two groups but with clinical difference in the group B since there was change in the secondary implant stability from one category to another according to implant stability quotient values.

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Conclusion: Although the application of platelet-rich fibrin before the insertion of the fixtures led to better stability through all the follow up periods compared to the normal healing process, this effect was not significant statistically, however, clinically was relevant according to implant stability quotient values.

Eficacia de la aplicación de fibrina rica en plaquetas en la estabilidad secundaria de los implantes: estudio comparativo

Palabras clave:

Implante dental, fibrina rica en plaquetas, estabilidad del implante, osteointegración.

RESUMEN

Antecedentes: La hipótesis de este estudio se basaba en el concepto de utilizar fibrina rica en plaquetas para mejorar la estabilidad de los implantes, acelerando la formación ósea y la osteointegración. La preparación de fibrina rica en plaquetas es un método sencillo, de bajo coste y mínimamente invasivo, para obtener una concentración natural de factores de crecimiento autólogos que se utiliza ampliamente en diferentes campos de la medicina para acelerar la cicatrización de tejidos blandos y duros.
Objetivo: Este estudio pretendía evaluar el efecto de la aplicación local de fibrina rica en plaquetas sobre la estabilidad de los implantes y determinar el efecto de otros factores, como las dimensiones del implante y el maxilar en el que se instaló, sobre la estabilidad del implante.
Pacientes y métodos: Este estudio clínico prospectivo comparativo se llevó a cabo en el Departamento de Cirugía Maxilofacial del Hospital Universitario Al-Yarmouk. Un total de 12 pacientes iraquíes de edad ≥ 18 años con una media de 46,25 años (9 mujeres y 3 hombres) cumplieron los criterios de elegibilidad y se inscribieron en este estudio tratados con 40 implantes dentales. Estos casos se asignaron a dos grupos, el grupo A (casos sencillos en los que los implantes se colocaron sin fibrina rica en plaquetas) y el grupo B (casos sencillos en los que los implantes se colocaron con fibrina rica en plaquetas). La estabilidad primaria se midió en el momento de la cirugía y la secundaria se midió 16 semanas después de la colocación del implante con el dispositivo Anycheck.
Resultados: Se instalaron 20 implantes dentales en cada grupo de estudio. El valor medio de la prueba de estabilidad primaria de los implantes en los grupos A y B fue de (63,00) y (63,85), respectivamente, sin significación estadística. Los valores medios de la prueba de estabilidad secundaria del implante 16 semanas después de la colocación del implante fueron de (69,05) y (70,00) para los grupos A y B respectivamente, también sin diferencia estadística entre los dos grupos, pero con diferencia clínica en el grupo B, ya que hubo cambio en la estabilidad secundaria del implante de una categoría a otra según los valores del cociente de estabilidad del implante.
Conclusiones: Aunque la aplicación de fibrina rica en plaquetas antes de la inserción de las fijaciones condujo a una mejor estabilidad a lo largo de todos los periodos de seguimiento en comparación con el proceso de cicatrización normal, este efecto no fue significativo estadísticamente, sin embargo, clínicamente fue relevante según los valores del cociente de estabilidad del implante.

INTRODUCTION

The history of the evolution of dental implants is a rich and fascinating through time. Since the beginning of mankind humans have used dental implants in one form or another to replace missing teeth[1].

In 1978, Dr. P. Brånemark presented a two-stage threaded titanium root form implant. He developed and tested a system using pure titanium screws which termed fixtures. These were first placed in the patient mouth in 1965 and were the first to be well-documented and the most well-maintained dental implants[2].

Platelet concentrates have been in use for the past 30 years, and its use come from the ability of the fibrin glue to enhance healing. Fibrin, the activated form of the plasmatic molecule fibrinogen, plays a determining role in the platelet aggregation during hemostasi[3]. A number of methods for platelet concentrates, since each technique leads to different products with different biology and possible uses[4].

Platelet-rich fibrin (PRF) originally described by Choukroun in (2000) is a second-generation platelet concentrate which contains platelets and growth factors and prepared from the patient's own blood without any anticoagulant or other artificial biochemical modifications[5].

The PRF is composed of three main components that have been noted as key components assisting in tissue regeneration, these include host cells, a three-dimensional fibrin matrix and various growth factors, these involve transforming growth factor beta (TGF-beta), platelet-derived growth factor (PDGF), vascular endothelial growth factor (VEGF), insulin growth factor (IGF) and epidermal growth factor (EGF)[6].

The PRF provides a condensed network of fibrin that is saturated with cytokines, growth factors that prolongs the effects of typical physiologic wound healing and optimizes bone grafting results. It is capable of generating both soft tissue and bone and can be used in combination with either a bone substitute or alone[7].

PATIENTS AND METHODS

This clinical prospective comparative study was conducted from December 2022 to May 2024 at the Maxillofacial Surgery Department of Al-Yarmouk Teaching Hospital as a fulfillment requirement for the fellowship in the Maxillofacial Surgery of the Iraqi Board for Medical Specializations. A total of 12 Iraqi patients aged ≥18 years and the mean was 46.25 years (9 females and 3 males) met the eligibility criteria and enrolled in this study treated with 40 dental implants (Neodent®, Brazil). These cases were allocated into two groups, group A (straightforward cases in which the implants were placed without PRF) and group B (straightforward cases in which implants were installated with PRF).

Patients of this study met certain criteria included patients who aged ≥ 18 years of both genders, straightforward cases (adequate alveolar ridge dimension), partially or totally edentulous alveolar ridges subjected to delayed implant placement protocol (≥ 6 months after teeth extraction) and patients maintaining reasonable oral hygiene.

The exclusion criteria involved systemic conditions that could interfere with normal healing or inability to withstand surgery such as platelet disorders, current pregnancy, psychosis, uncontrolled systemic diseases like uncontrolled diabetes, the presence of infection or inflammation in the planned implant zone, advanced and complicated cases according to SAC (Straightforward, Advanced and Complicated cases) classification, limited mouth opening and patients with signs of considerable parafunctional habits such as bruxism and clenching.

The patients were informed about the procedures with the possible intraoperative and postoperative sequalae. Following the verbal approval of the patients to participate with the current study, they signed a special consent.

This research was approved by committee of the scientific council of maxillofacial surgery.

Preoperative assessment

A detailed medical and dental history was obtained from patients followed by clinical examination including extraoral and intraoral examinations for facial symmetry, smile line, color of skin, sclera, and conjunctiva, cervical regional lymph nodes, temporomandibular joint condition, mouth opening, oral hygiene, periodontal status and any clinical evidence of parafunctional habits. All teeth being inspected for caries and gingival condition. Space analysis for the proposed implant site was performed in which the width of the alveolar ridge, the intercoronal (mesiodistal) distance and the distance between alveolar ridge and opposing teeth or ridge where measured utilizing an osteometer (caliper). This succeeded by investigations such as orthopantomogram and cone beam computed tomography to documentation and assessment of the available alveolar bone height taking in consideration the amount of magnification and important anatomical structures.

Operative phase

PRF preparation

After completion of the osteotomy site, skin rubbing with alcohol was done, tourniquet was applied on the arm, whole blood was collected from one of the superficial veins in the cubital fossa into plain glass tube, 5-10 ml according to the number of DI introduced and was immediately centrifuged at 3000 rpm for 10 minutes.

The PRF clot was pulled from the tube and separated from the blood clot by milking action with tweezers and placed on a wet gauze (with few drops of normal saline solution 0.9 %) (Figure 1).

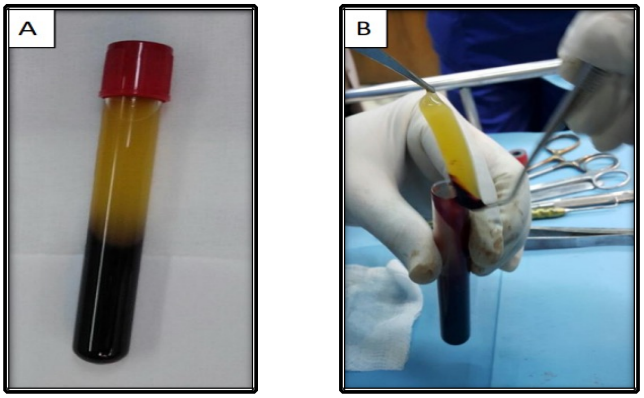

Figure 1. Preparation of PRF. A: the PRF in the tube after centrifugation. B: the PRF is pulled from the tube and separated from red corpuscle base.

Implant site preparation

Group A (straight forward cases without PRF): The surgery started by anesthetizing the area with local infiltration technique using Lidocaine 2 % with epinephrine (1:80,000). An extensive

three sided or limited (papilla-saving) full thickness mucoperiosteal flap was reflected to expose the crestal and buccal alveolar bone using Goldman fox periosteal elevators. The preparation of the implant bed was initiated with the point drill using a dental engine handpiece set at 600-800 rpm and a torque equal to 35 N/cm to precisely locate the osteotomy site. The next step was the use of drill ⌀ 2.0 mm to increase the diameter of initial osteotomies, progressing with a sequential drilling technique until reaching the requested final drill. The use of countersink drill was optional according to bone density, as demonstrated in Figure 2.

The implants were installed by a surgical micro-motor handpiece with a speed of 25 rpm and a torque of 35 N/cm. Final seating of DI was completed manually into its final position with the aid of a ratchet.

The primary stability (T1) was measured immediately after implant installation using AnyCheck device with the standard healing abutment 3.5 mm in height & 4.5 mm in diameter (Figure 3).

Group B (straightforward cases with PRF): Implants were placed using sequential drilling technique with the same way as in group A to the final requested DI size. After preparation of the PRF, the osteotomy site was irrigated with normal saline solution, the PRF clot was taken and gently introduced into the osteotomy site (Figure 4). The implant was finally placed in its prepared site and wound closure was done.

The primary stability was measured after implant insertion using AnyCheck device with a standard healing abutment, then the healing abutment is removed and closure cap is inserted as in group A.

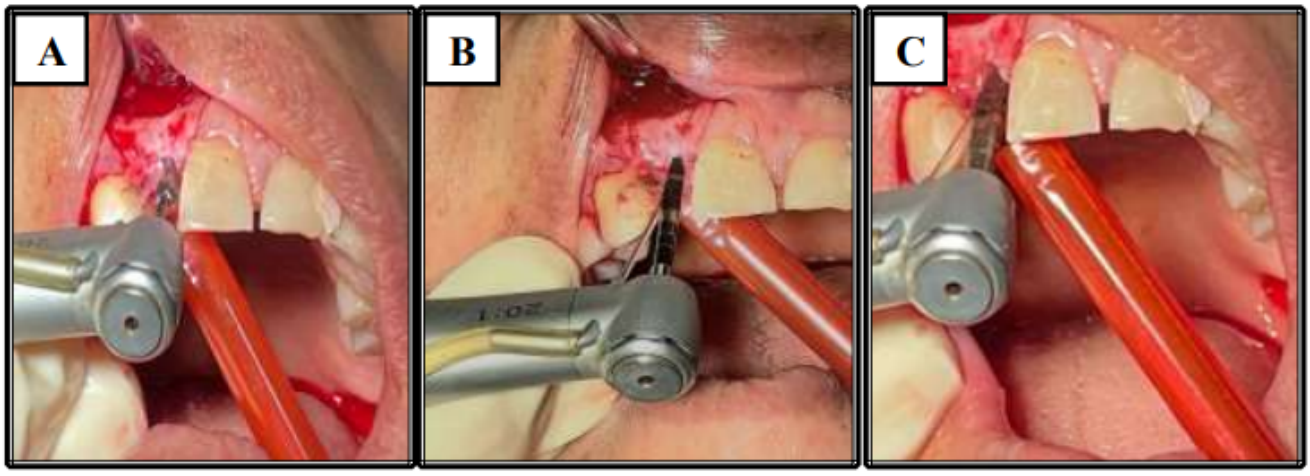

Figure 2. Preparation of osteotomy site of tooth #12. A: the point drill to precisely locate the osteotomy site. B: the next drill ⌀ 2.0 mm to increase the diameter of initial osteotomies. C: the final drill ⌀ 3.5 mm.

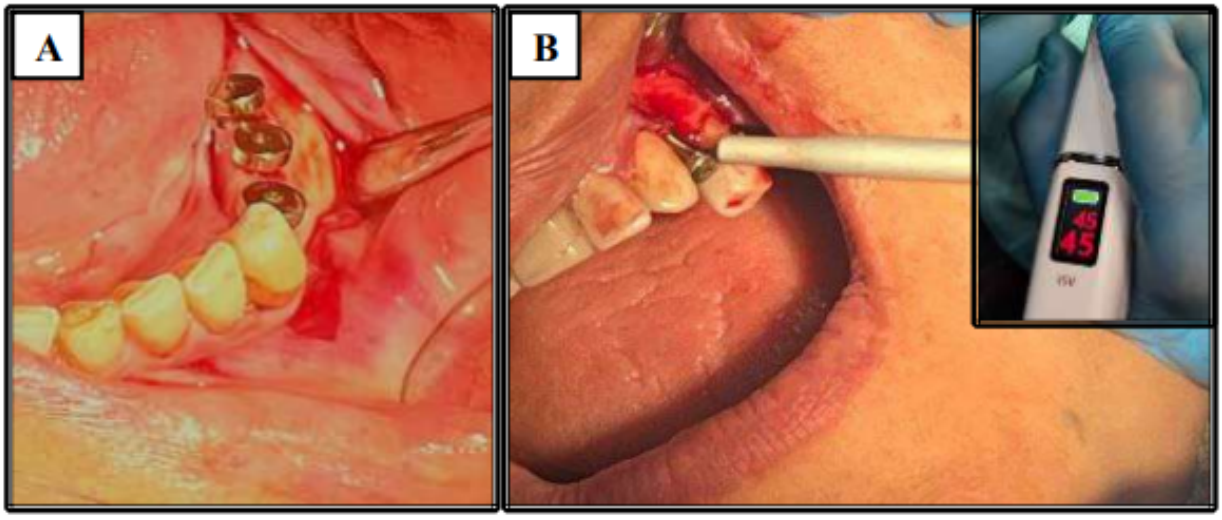

Figure 3. Measurement of primary implant stability. A: a standard healing abutment screwed into the implant fixture. B: the implant stability measurement was performed using AnyCheck device.

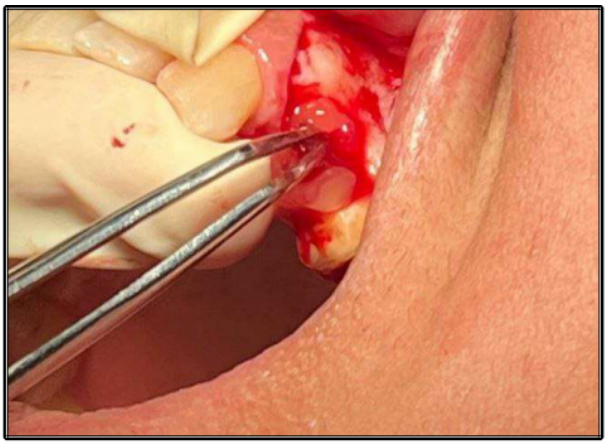

Figure 4. Application of PRF clot into the prepared osteotomy site.

Patients' follow-up

Oral gauze pads were placed after the surgery and kept for 30 minutes. On the day of surgery, the intermittent application of cold packs over the skin of the face for 15 minutes for 3 hours. As swelling is a normal sequela after oral surgery that normally reaches its peak by the 3rd day and then starts to resolve. Acetaminophen 1000 mg tablet is administered on need as a good choice of pain killer. The antibiotics prescribed was Co-amoxiclav 625 mg tablet and Metronidazole 500 mg tablet 3 times a day for 5 days. The patients were instructed to attend for the 1st follow up visit 7-10 days postoperatively for sutures removal and checkup.

The second stage DI uncoverage surgery was accomplished at the 16 weeks (T2) follow-up visit, infiltration of local anesthesia was done, the fixture was uncovered using a surgical blade No.15 with the cover screw removed and suitable healing abutment of standard height (3.5 mm) was screwed into the fixture and the secondary stability was measured.

Statistical analysis

The statistical analysis was performed using GraphPad prism software version 8.4.3. Shapio-Wilk test was performed to test normality of the distribution; the data were not normally distributed. In the current study the following statistical analysis were utilized: Wilcoxon signed-rank test is used to compare two related samples, matched samples, or to conduct a paired difference test of repeated measurements on a single sample to assess whether their population mean ranks differ. Paired t-test is used when we are interested in the difference between two variables for the same subject. Unpaired t test used to compare the means of two unmatched groups, assuming that the values follow a Gaussian distribution. Mann-Whitney U test is used to compare differences between two independent groups when the dependent variable is either ordinal or continuous, but not normally distributed.

RESULTS

Twelve patients were contributed in this study (9 females and 3 males) aged from 18-67 years with a mean of 46.25 years. The total number of DI inserted in group A & B < 46 years were 8 (20 %), while, the age ≥ 46 years was received 32 DI. Concerning gender, 23 (57.5 %) of DI were placed in female patients. Regarding the jaws, the statistical analysis demonstrates that the larger number of DI inserted in the maxilla which was 60 %, while 40% of them were installated in the mandible. The number of DI located in the sinus zone was the prominent included 15 (37.5 %). The research data reported that DI diameter of 3.5 mm was the dominant one utilized in 18 (45 %) of DI. The results of the study demonstrates no statistical significant change between the mean of primary and secondary IST values of the group A (T1= 63.00 vs. T2= 69.05) and group B (T1= 63.85 vs. T2= 70.00) during the study period as appeared in Figure 5.

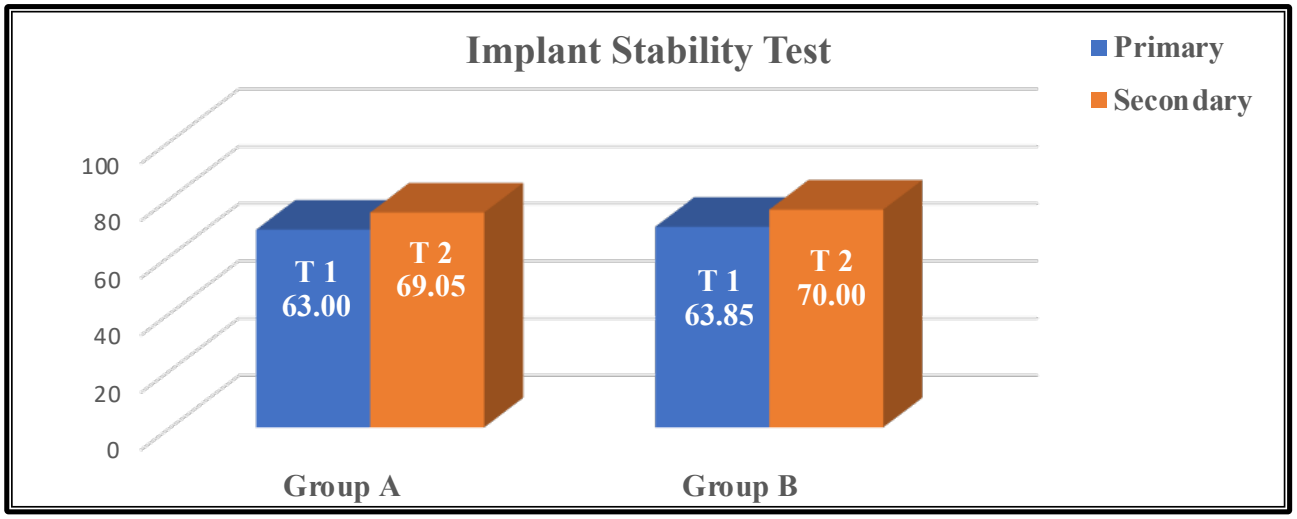

Figure 5. A bar chart illustrating the mean implant stability change between the two groups.

There was significant difference in the secondary implant stability (p = 0.01) in group A with age ≥ 46 years. Also, there was a significant change in the secondary stability in group B (65.59 ± 7.0 vs. 71.01 ± 2.9). On the other hand, there was no significant change regarding age < 46 in both groups, as illustrated in Table I. Regarding the gender, there were a significant difference in the primary and secondary implant stability between the two groups with males. While in females, there was a significant change in the secondary implant stability in group A and group B as demonstrated in supplemental (Table I).

There was a statistical significant effect in the secondary stability in group A (T1 = 59.23 ± 8.1 vs. T2 = 65.00 ± 7.4) and group B (T1 = 59.18 ± 6.1 vs. T2 = 68.27 ± 5.0) in the maxilla. In the mandible, there was a significant difference in the secondary implant stability between group A and group B (A = 76.57 ± 3.2 vs. B = 72.11 ± 2.9). Also, there was a significant difference between primary and secondary implant stability in group A (T1 = 70.00 ± 7.2 vs. T2 = 76.57 ± 3.2).

According to the results obtained in this study (Table II) demonstrates a significant difference between T1 and T2 values of the implant stability of both groups with DI dimension 3.5 and a significant change between T1 (65.82 ± 8.5) and T2 (71.55 ± 2.7) in group B with DI dimension > 3.5.

In the present study, the patients included were not subjected to any intraoperative and postoperative complication. The total number of DI installed in this study was 40. All of them were survived after 16 weeks.

Table I. Implant stability measurements and demographic data

Implant stability-Demographic data										
Age	**< 46**					**≥ 46**				
	T1	**P1**	**T2**	**P2**	**P**	**T1**	**P1**	**T2**	**P2**	**P**
Group A	53.0 ± 4.0	0.7704 NS Unpaired t-test with Welch's correction	63.0 ± 9.7	0.8804 NS Unpaired t-test with Welch's correction	0.0712 NS Paired t-test	66.33 ± 8.0	0.5309 NS Mann Whitney test	71.1 ± 7.1	0.9968 NS Unpaired t-test with Welch's correction	**0.0151** * Wilcoxon matched pairs signed rank test
Group B	54.0 ± 4.6		64.0 ± 7.9		0.0634 NS Paired t-test	65.59 ± 7.0		71.06 ± 2.9		**0.0005** *** Paired t-test
Gender	**Male**					**Female**				
	T1	**P1**	**T2**	**P2**	**P**	**T1**	**P1**	**T2**	**P2**	**P**
Group A	56.0 ± 1.4	**0.0007** *** Unpaired t-test with Welch's correction	59.0 ± 1.4	**0.0052** ** Unpaired t-test with Welch's correction	Small sample	63.78 ± 9.4	0.0943 NS Unpaired t-test with Welch's correction	79.17 ± 8.0	0.4905 NS Unpaired t-test with Welch's correction	**0.0061** ** Paired t-test
Group B	66.0 ± 7.3		70.87 ± 9.0		**0.0031** ** Paired t-test	57.40 ± 5.9		67.40 ±7.4		**0.0025** ** Paired t-test

Table II. Implant stability changes concerning implant dimension

Implant stability										
Dimension	**3.5**					**> 3.5 (4.0,4.3)**				
	T1	**P1**	**T2**	**P2**	**P**	**T1**	**P1**	**T2**	**P2**	**P**
Group A	62.10 ± 8.3	0.8500 NS Unpaired t test with Welch's correction	68.10 ± 8.7	0.9974 NS Unpaired t test with Welch's correction	**0.0158** * Paired t-test	63.90 ± 10.5	0.6521 NS Unpaired t test with Welch's correction	70.00 ± 8.3	0.5858 NS Unpaired t test with Welch's correction	0.0895 NS Paired t-test
Group B	61.44 ± 6.6		68.11 ± 5.6		**0.0008** *** Paired t-test	65.82 ± 8.5		71.55 ± 2.7		**0.0143** * Paired t-test

DISCUSSION

In the present research, a clinical analysis of the data was contemplated and performed based on the IST-scale, in which DI stability values remained or changed to a different level 16 weeks after implant insertion which represented the secondary stability (T2) when compared to the baseline data that measured immediately after implant installation which represented the primary stability (T1).

The average IST value of primary stability in group A & B was (63.00) and (63.85), respectively with no statistical significance. The average IST values 16 weeks after DI placement were found to be (69.05) and (70.00) for group A and B, respectively also with no statistical difference between the two groups.

This result go in the same line with the study of Amjed & Ali, 2017[8] regarding the effect of PRF on the secondary implant stability who reported that the implant stability quotient in the study group with PRF (T1 = 73.15 and T2 = 74.46) was higher compared to the control group without PRF (T1 = 75.52 and T2 = 75.04) but this elevation was not significant.

Jia et al., 2022[9] in their study claimed that there was no statistical difference between the two study groups.

The effect of the platelet concentrates is mainly achieved by a large number of released growth factors which promotes bone regeneration and repair, and the duration of growth factors released by PRF is within 14 days.

The PRF increased bone formation around dental implants and osseointegration increased significantly as a result of this therapy[10]. The application of PRF improved implant stability during the early healing period and provided rapid osseointegration[11].

Furthermore, Aseel & Athraa, 2013[12] in an experimental animal study observed that implants placed with PRF had a faster bone formation and more rapid healing process than that which appeared in implant placed without PRF and these results proved via histological examination.

Therefore, they concluded that PRF material was osteoinductive material that enhances the osseointegration process in titanium implant site in comparison to the normal physiological healing process, and it can be suggested for beneficial use in the practice of dentistry implantation, oral surgery since it enhances osseointegration, reduce the period of patient suffering and the incidence of postimplant complications.

The analysis of the data illustrated and confirmed that not all the statistically significant results essentially being clinically relevant and this supported by Guller, 2007[13]. Accordingly, in the present research, the statistical analysis that was mentioned earlier not corresponds to the clinical analysis in terms of primary and secondary stability since there is change in the stability from one category to another one in both groups according to IST values and there is no change in category of implant stability according to ISQ values (group A, T1 = 63.00 vs. T2 = 69.05 and group B, T1 = 63.85 vs. T2 = 70.00).

The current study registered no statistical significant difference in implant stability value between study groups concerning primary and secondary stability in patients < 46 years. While in those with age ≥ 46, there was a low significant difference in the secondary stability (p = 0.0151) of the group A (66.33 ± 8.0 vs. 71.1 ± 7.1) which can be considered as a normal remodeling process during osseointegration in which the stability increased during time independently on the recipient site or age group.

On contrary, in group B of age ≥ 46, there was a highly significant change in the secondary stability (p = 0.0005), this result is in accordance with the study accomplished by Serhat et al., 2022[14] who investigated the effect of PRF on implant stability and found that PRF had positive effect on stability and the ISQ values were higher in study group.

Regarding gender, there was a significantly higher primary implant stability (p = 0.0007) between group A and B (56.0 ± 1.4 vs. 66.0 ± 7.3) in male patients. The density of the mandible is better than the maxilla as supported by Tina et al., 2013[15] and the primary stability positively correlated with the amount and density of the bone available as stated by Joaquín et al., 2020[16] this might be related to the clinical distribution of DI which was higher in the mandible than in maxilla for males, as (9 out of 15 DI installed in mandible) for group B versus (zero DI) for group A.

The dental implant diameter of 3.5 mm that has been installed had a statistically significant effect on secondary stability for group A and B, while those of > 3.5 mm of group A had no statistical significant change on the secondary implant stability, however it is clinically considered irrelevant since there was a change in category from moderate to high stability. This result is in the same line with Milan et al., 2023[17] (regarding group A) who claimed that wider dental implants diameter increase the resonance frequency analysis. Secondary stability depends on primary stability and has been reported to increase four weeks after placement of the implant (T1= 72.34 vs. T2= 74.54) as supported by Andreas et al., 2020[18].

This clinical study reported a survival rate of 100 % for the 40 dental implants installed with delayed placement protocol and followed-up for 16 weeks which is similar to the previous studies IGözde et al., 2021[19] who reported a success rate of 100 % after 6 months, 1 year, and 2 years follow-up after loading of implants. The results are better than the study of Amjed & Ali, 2017[8] who reported implant survival rates of 96.56 % in their study regarding the effect of PRF on the secondary implant stability.

Limitation of the study

Main limitations of this research are the lack of randomization and the scarce number of patients evaluated.

CONCLUSION

Although the application of PRF in the prepared implant sockets before the insertion of the fixtures leads to better stability through all the follow up periods compared to the normal healing process, but this effect was not significant statistically. There was no difference regarding the survival rate of the dental implant since for both groups were 100 %.

CONFLICT OF INTEREST

Both authors declare no conflict of interest.

FUNDING

There is no funding to declare.

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