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Comparison of Advanced Platelet Rich Fibrin versus Platelet Rich Fibrin as a Gap Filling Material in Immediate Implant Placement

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Introduction

Dental implants have revolutionized modern dentistry by providing a reliable and long-lasting solution for the replacement of missing teeth. A crucial factor in the success of dental implants, particularly in the posterior regions of the mandible, is the promotion of optimal bone and soft tissue healing. [1]

Various biomaterials have been developed and tested to enhance osseointegration, accelerate healing, and improve long-term outcomes of implants. One such biomaterial that has gained considerable attention is platelet-rich fibrin (PRF), an autologous blood product known for its regenerative potential. [2][3]

Platelet-rich fibrin (PRF) was initially introduced by Choukroun et al, 2006. Platelet-rich fibrin is a second-generation platelet concentrate that emerged as an improvement over platelet-rich plasma (PRP)[4], offering several benefits such as the release of growth factors that promote tissue regeneration and wound healing.[5][6] Unlike PRP, PRF is free of anticoagulants or additives, making it a purely autologous material. It is prepared by centrifugation of the patient's blood, which separates the blood components and yields a fibrin clot rich in platelets, leukocytes, and growth factors. PRF has been widely used in dental and medical fields, particularly in oral surgery, periodontology, and implantology, due to its ability to promote soft and hard tissue healing.[7][8]

However, despite its success, Platelet-rich fibrin (PRF) has limitations, such as its short-lived release of growth factors and limited structural integrity, which has spurred the development of advanced forms of PRF.[9][10] Advanced PRF (A-PRF), a newer variation, is produced using a slower and longer centrifugation process, which results in a higher concentration of leukocytes and platelets and a more extended release of growth factors.[11]

This modification aims to enhance the regenerative potential of PRF, making it more suitable for complex procedures like immediate implant placements,[12] especially in regions like the posterior area of the mandible, where healing can be challenging due to anatomical and biomechanical factors.

Immediate implant placement, where the implant is placed directly into the extraction socket following tooth removal, has become a common practice due to its potential to reduce treatment time and prevent alveolar bone resorption. However, the success of immediate implants depends heavily on the proper management of the extraction socket, which often requires the use of grafting materials to fill the gap between the implant and the socket walls and to promote bone regeneration. [12]

Both PRF and A-PRF have been proposed as suitable filling materials for this purpose, but there is limited clinical evidence comparing their efficacy in terms of bone and soft tissue healing, particularly in challenging areas such as the posterior regions.[13][14]

The posterior region of the jaw presents unique challenges for implant placement due to several factors, including reduced bone quality and quantity, increased masticatory forces, and the proximity of vital anatomical structures such as the the inferior alveolar nerve. The success of implants in these regions is contingent on the rapid formation of new bone around the implant to ensure primary stability and long-term osseointegration. [15][16]

PRF, with its regenerative properties, has been shown to aid in this process, but it remains unclear whether the newer A-PRF offers significant clinical advantages over PRF.

The key differences between traditional platelet-rich fibrin (PRF) and advanced platelet-rich fibrin (A-PRF) lie in the processing protocols, particularly in the centrifugation speed and time. PRF is typically obtained by centrifuging blood at a relatively high speed (around 2,700-3,000 revolutions per minute or RPM) for a short duration, usually 8-12 minutes. This results in a fibrin clot that contains platelets, leukocytes, and a network of growth factors. However, this method yields a more compact clot with a relatively rapid release of growth factors (7-14 days), leading to a shorter duration of biological activity.[17]

In contrast, A-PRF is produced using a lower centrifugation speed (about 1,300-1,500 RPM) and a longer centrifugation time, ranging from 10-14 minutes. This slower and prolonged process allows for the collection of a PRF matrix that is more porous and contains a higher concentration of leukocytes and platelets. The altered centrifugation protocol of A-PRF results in a more homogenous distribution of cells and a slower, more sustained release of growth factors (10-28 days) such as transforming growth factor-beta (TGF-β), vascular endothelial growth factor (VEGF), and platelet-derived growth factor (PDGF). These factors contribute to enhanced angiogenesis, tissue regeneration, and a prolonged healing response, making A-PRF potentially more effective in promoting both soft tissue and bone regeneration compared to PRF. [18][19][20]

Aim of the Study:

The aim of the study is a clinical and radiographic comparison between advanced platelet rich fibrin versus platelet rich fibrin as a gap filling material in immediate implant placement.

Materials and Methods

Study setting:

This study will be conducted on (16) patients in the outpatient clinic of Oral and Maxillofacial Surgery department, Faculty of Oral and Dental Medicine, Delta University for Science and Technology. The selected patients has a badly decayed mandibular posterior teeth which needs to be extracted and require teeth replacement by dental implant. The selected patients will undergo immediate dental implant placement and platelet rich fibrin or advanced platelet rich fibrin will be used as a filling material in the jumping gap.

Criteria for patients' selection

- **Inclusion criteria**

1- The selected patients has a badly decayed mandibular posterior teeth which needs to be extracted and require teeth replacement by dental implant.
2- Healthy patients who are classified according to the American Society of Anesthesiologists (ASA)(2022) physical status classification as class I.
3- Patient aged between 25 and 60 years old.
4- Surgical site with initial alveolar ridge width range between (4-6 mm).
5- Sufficient interocclusal space (6-9 mm)
6- Adequate healthy gingival tissue.
7- Good oral hygiene.
8- Willing to complete the study.

- **Exclusion criteria**

1- Presence of any systemic condition affecting wound healing and success of procedures.
2- History of alcohol or drug dependency. psychological factor that might affect the surgical or prosthodontic treatment.
3- Non-Smokers.
4- Head and neck radiation treatment.
5- Severe bruxism or clenching habits.
6- Active periodontal diseases and periapical lesions not chronic infections.

Sample size:

Using G power program version 3.1.9.7 to calculate sample size based on expected effect size of 2.02 (1.56 ±0.52& 0.69± 0.32) depending ,using 2-tailed test , α error =0.05 and power = 95.0% , the total calculated sample size will be 16 divided into two groups.

Study Design:

For the study production the total number of the included patients will be 16 with respect to the inclusion criteria that is selected, patients will be randomly divided into two equal groups A&B, both of them will under-go Immediate implant placement each group will have its unique method of Filling up the jumping gap around the dental implant either by the use of Platelet-rich fibrin (PRF) or Advanced platelet-rich fibrin (A-PRF).

Group A: The jumping gap will be filled with Platelet-rich fibrin (PRF).
Group B: The jumping gap will be filled with Advanced platelet-rich fibrin (A-PRF).

Randomization:

Each patient will be joined either to group A or B immediately after tooth extraction procedure through a random lottery mechanism (a startup number of 16 pre-printed paper for the first patient lottery, half of them with Platelet-rich fibrin (PRF) and the other with Advanced platelet-rich fibrin (A-PRF) with a probability of 50%) and the offending patient will choose the pre-printed paper with the specific procedure randomly and blindly.

Materials:

1- Platelet rich fibrin kit
2- Centrifuge device
3- 10 ml PRF tubes and A-PRF tubes
4- Two piece root form implant
5- Gelatin sponge

Surgical Procedures:

After administration of Local anesthesia, gentle atraumatic extraction is performed for the nonrestorable tooth, followed by careful cleaning of the extraction socket. Drilling for the implant begins to create the correct depth and diameter for implant placement. The implant is installed according to manufactures instructions, ensuring proper seating and stability to promote integration with the surrounding bone.

For Group A, PRF preparation involves collecting 20 mL of venous blood into anticoagulant-free tubes, followed by centrifugation at 2,700-3,000 RPM for 8-12 minutes. This process separates the blood into layers, from which the fibrin clot is carefully extracted.

For Group B, A-PRF is prepared similarly but centrifuged at a lower speed (1300-1500 RPM) for 12-14 minutes to yield a higher concentration of platelets and leukocytes. After preparation.

PRF and A-PRF are applied to the implant site to aid tissue regeneration and integration. Application of Gelatin Sponge to cover the implant before suturing over the implant.

Key Differences Between PRF and A-PRF Preparation:

- **Centrifugation Speed**: A-PRF is prepared at a lower speed compared to traditional PRF to yield a richer concentration of leukocytes.
- **Fibrin Clot Characteristics**: A-PRF tends to have a softer, more pliable fibrin network due to the different processing methods, which may enhance its handling during surgical application.
- **Cellularity**: A-PRF has a higher concentration of white blood cells, contributing to its potential benefits in promoting healing and reducing inflammation.

Post-operative phase:

Apply gauze with light pressure to the surgical area to manage any bleeding. Instruct the patient to keep the gauze in place for 30–45 minutes and to replace it if bleeding persists.

Post-operative instructions:

The patient will be advised to avoid chewing hard foods at the implant site for 2 months, maintain oral hygiene with soft tooth brush. And avoid touching or disturbing surgical site.

Post-operative medication:

Includes Antibiotics (Augmentin: amoxicillin and clavulanic acid) 1g, Analgesics (Brufen; ibuprofen) is prescribed twice daily for 3 days, along with Anti-inflammatory tablets. Use of mouth wash (Orovex-H) rinse twice daily.

Prosthetic phase:

Three months after implant placement, expose the fixture, followed by the placement of gingival formers for 1-2 weeks to shape the soft tissue around the implant collar, ensuring proper gingival contour. Impressions will be taken. Patients in both groups will receive final restoration, with the abutments secured to the implants, ensuring functional loading.

Evaluation:

1) Clinical evaluation:

A) Implant Stability:

Implant stability will be measured by Resonance Frequency Analysis (RFA) ISQ unit at 3 months and 6 months post-operative .

The index of ISQ 1-100

-ISQ less than 60 = low stability.

-ISQ 60-70 = medium stability.

-ISQ more than 70 = high stability.

An ISQ value above 70 is generally considered a sign of good implant stability, while values below 60 may suggest caution before loading the implant.

B) Insertion torque:

Measurement Tools: A torque wrench is used to measure the insertion torque during implant placement.

Torque Values: Generally, insertion torque values between 25-45 N/cm are considered optimal for primary stability. Lower torque values may indicate insufficient primary stability, while excessively high values (over 50 N/cm) could cause excessive stress on the surrounding bone.

Comparative Analysis: Compare the insertion torque values between the PRF and A-PRF groups to evaluate whether one preparation method offers superior initial stability, potentially affecting long-term outcomes.

C) Biochemical assessment:

Gingival cervical fuild marker a baseline and post-surgery.

2) Radiographic evaluation:

A) <u>Marginal Bone Loss:</u> A CBCT measurement will be done at immediate post-operative and after 6 months will also help assess the amount of marginal bone loss around the implant, which is a critical indicator of implant success. Measurements can be taken from the implant-abutment junction to the crest of the surrounding bone

B) <u>Buccal/Lingual plate of bone thickness</u>: A CBCT measurement will be done at immediate post-operative and after 6 months.
The measurement involves identifying the midpoint of the implant and drawing a perpendicular line from this point to the outer buccal cortical plate. This measurement helps evaluate the amount of buccal bone that remains after implant placement and is essential in predicting long-term implant stability and success, as thinner buccal bone can be more prone to resorption

Statistical analysis:

Data will be analyzed using SPSS (statistical package for social sciences) version 22. Qualitative data will be presented as number and percent, Quantitative data will be tested for normality by Kolmogrov-Smironv test then described as mean and standard deviation for normally distributed data and median and range for non-normally distributed. The appropriate statistical test will be applied according to data type with the following suggested tests : Chi-Square for categorical variable , Student t test and Mann Whitney U test for continuous variables.

Ethical Considerations:

- The study will adhere to the Declaration of Helsinki and obtain ethical approval from the [Faculty of Oral and Dental Medicine, Delta University].
- Informed consent will be obtained from all participants.
- Patient confidentiality and data security will be maintained throughout the study.
- Before starting our proposal, the sample size is calculated by the G-power analysis software for power and significance
- After the study, the collected data will be extracted and statistically analyzed using statistical package for social science software (SPSS)

Estimated time:

- The estimated time will be 9 months.

Estimated cost:

- The estimated cost will be about 300,000 EGP.

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