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Comparative efficacy of platelet-rich fibrin matrix versus guided tissue regeneration membrane with DFDBA in immediate implant placement: A randomized controlled clinical trial

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Abstract:

Management of the peri-implant jumping distance remains challenging during immediate implant placement because inadequate bone fill may compromise osseointegration. This randomized trial included 30 systemically healthy patients receiving DFDBA with GTR membrane (n=15) or autologous PRFM (n=15) using a two-stage protocol. Plaque, gingival, bleeding, probing depth, attachment loss and crestal bone levels were assessed at baseline, 3 and 6 months and post-restoration. Both groups achieved 100% implant survival and success, with healthy probing depths and progressive reductions in plaque and gingival inflammation. No significant intergroup differences were observed, indicating comparable clinical outcomes with DFDBA combined with GTR membrane or PRFM.

Keywords: Platelet-rich fibrin matrix (PRFM), guided tissue regeneration (GTR) membrane, DFDBA, immediate implant placement, randomized controlled trial, bone regeneration

Background:

Immediate implant placement has become a preferred choice in modern implantology, reducing the number of surgical interventions and overall treatment time while preserving pre-existing soft and hard tissue architecture, thus improving patient comfort [1-3]. However, the anatomical discrepancy between the implant fixture and the walls of the fresh extraction socket creates a horizontal void referred to as the "jumping distance" [4]. When this horizontal gap exceeds 1.5 to 2 mm, the predictability of bone fill and osseointegration becomes compromised, potentially leading to loss of bone-to-implant contact, crestal bone resorption and mucosal recession [5, 6]. To mitigate the jumping distance, grafting with an osteoconductive scaffold such as Demineralized Freeze-Dried Bone Allograft (DFDBA) has become standard practice [7]. DFDBA maintains the structural integrity of the socket and provides a reliable framework for de novo bone formation [8]. When accompanied by Guided Tissue Regeneration (GTR) membranes, it prevents the downgrowth of epithelium, promoting desired cells at the defect site [9]. Platelet-Rich Fibrin Matrix (PRFM) is a condensed form of platelet concentrate harboring a dense fibrin network, improving mechanical stability and allowing controlled release of growth factors [10]. Formed under specific centrifugal conditions, PRFM produces a denser matrix devoid of leukocytes with superior handling characteristics. This architecture mimics natural extracellular matrix scaffolds, conducive for cellular migration and proliferation. PRFM has gained relevance for improving soft tissue esthetics, bone regeneration and reducing postoperative inflammation [11]. Therefore, it is of interest to report the clinical efficacy of PRFM combined with DFDBA compared to DFDBA with a GTR membrane in implants placed into fresh extraction sockets using

a two-stage protocol, evaluating crestal bone changes, soft tissue responses and overall clinical success.

Materials and Methods:**Study design and patient population:**

This prospective randomized controlled trial enrolled 30 patients requiring single-tooth extraction, recruited from the outpatient Department of Periodontology, Maitri College of Dentistry and Research Centre. Ethical clearance was obtained from the Institutional Ethical Committee and Review Board (Ref: MCDRC/2024/APR/435 and MCDRC/2024/APR/434).

Patients were randomly allocated into two equal groups:

- [1] **Group 1 (n=15):** DFDBA graft covered with a GTR membrane.
- [2] **Group 2 (n=15):** DFDBA graft covered with autologous PRFM.

Inclusion criteria:

Teeth indicated for extraction due to non-restorable conditions; good oral hygiene; thick gingival biotype; intact alveolar bony walls; presence of ≥ 4 mm of bone beyond the root apex; D-1, D-2, or D-3 bone quality; and presence of opposing and adjacent natural teeth.

Exclusion criteria:

Systemic conditions compromising bone healing, severe inter-arch space discrepancies, parafunctional habits, dental malalignment, tobacco use or alcoholism, inadequate keratinized gingiva (<2 mm), debilitating temporomandibular joint pathosis, untreated dental diseases and pregnant or lactating mothers.

Clinical and radiographic measurements:

Clinical parameters were assessed at baseline, 3 months, 6 months and 3 months post-restoration:

- [1] **Full Mouth Plaque Index (FMpi):** Turesky-Gilmore-Glickman modification of the Quigley-Hein index.
- [2] **Gingival Index (GI):** Loë and Silness criteria.
- [3] **Peri-implant health:** Modified Plaque Index (Mpi) and Modified Bleeding Index (Mbi) according to Mombelli.
- [4] **Probing Depth (PD) and Clinical Attachment Loss (CAL):** Recorded using a UNC-15 probe at four sites per implant.
- [5] **Implant stability and bone preservation:** Clinical Implant Mobility Scale (CIMS) and crestal bone changes via standardized periapical radiographs and CBCT.

Surgical protocol:

After comprehensive evaluation and Phase I periodontal therapy, patients received prophylactic Amoxicillin-Clavulanic acid (Augmentin 625 mg) one hour preoperatively. Local anaesthesia was administered with 2% lignocaine hydrochloride with 1:100,000 adrenaline. Sulcular incisions were made buccally and lingually; full-thickness mucoperiosteal envelope flaps were reflected. Atraumatic extraction was performed using periotomes and extraction forceps to preserve the buccal cortical plate. The socket was thoroughly debrided, granulation tissue removed and ridge alveoloplasty performed where necessary. The socket was curetted to induce fresh bleeding and irrigated with normal saline. Osteotomies were prepared using the OSSTEM TS III implant system with maximum utilization of apical bone beyond the extraction socket for primary stability. Implants were placed 3 mm apical to the free gingival margin. All circumferential defects measuring ≥1.5–2 mm were grafted with DFDBA. For Group 1, a GTR membrane was adapted over the graft. For Group 2, PRFM was prepared using MERISIS PRFM tubes with gel separator and activator; 10 ml of blood collected from the antecubital vein was centrifuged at 3000 rpm for 10 minutes (single-spin protocol) and the resulting PRFM clot was placed over the graft. Flaps were repositioned and secured with simple interrupted sutures. Post-operatively, patients received cap. Amoxicillin 500 mg t.i.d., Tab. Metronidazole 400 mg t.i.d. and Tab. Ibuprofen t.i.d. for five days, along with 0.2% chlorhexidine gluconate rinses. Sutures were removed at 7–10 days. Second-stage surgery was performed at 3 months using a flapless approach with trephine bur uncoverty and gingival former placement. Single-unit porcelain-fused-to-metal (PFM) crowns were delivered at 3 months post-abutment connection using a delayed loading protocol.

Statistical analysis:

Independent samples t-test and paired t-test were used for inter-group and within-group comparisons respectively. Chi-square test was used for qualitative data. Statistical significance was set at $p<0.05$.

Results:

The two groups were well matched at baseline. Mean age was 36.40±5.89 years in Group 1 and 35.07±4.67 years in Group 2

($p=0.492$). Gender distribution and tooth replacement sites were comparable between groups ($p=0.713$ and $p=0.651$, respectively). Demographic characteristics are presented in (Table 1). Both groups demonstrated progressive and statistically significant reductions in plaque accumulation and gingival inflammation throughout the follow-up period, as detailed in (Tables 2 and 3). Site-specific peri-implant measurements mirrored the full-mouth trends. Plaque accumulation and bleeding tendencies at implant sites diminished substantially across the follow-up period (Tables 4 and 5). At 6 months, all implant sites presented with physiologically healthy sulci. No sites exhibited pathological probing depths ≥3 mm. Mean probing depths and clinical attachment loss values are shown in (Table 6). Radiographic assessment using CIMS indicated complete crestal bone maintenance across all implants in both groups at the 6-month evaluation (Table 7). All implants in both groups achieved primary stability, demonstrated radiographic osseointegration at 6 months and were free of mobility or periapical radiolucency, yielding a 100% implant survival and success rate in both cohorts (Table 8).

Table 1: Demographic Characteristics

Parameter	Group 1: GTR+DFDBA (n=15)	Group 2: PRFM+DFDBA (n=15)	p-value
Age (Mean±SD)	36.40±5.89	35.07±4.67	0.492
Gender (M/F)	7 (46.7%) / 8 (53.3%)	6 (40%) / 9 (60%)	0.713
Site (Ant/Pre/Mol)	4 / 7 / 4	2 / 8 / 5	0.651

Table 2: Full Mouth Plaque Index (FMpi)

Time Point	Group 1 (Mean±SD)	Group 2 (Mean±SD)	p-value
Baseline	3.89±0.25	3.98±0.24	0.312
3 Months	3.01±0.22	3.08±0.24	0.389
6 Months	2.21±0.21	2.28±0.24	0.412
3M Post-restoration	1.57±0.17	1.63±0.19	0.423

Table 3: Gingival Index (GI)

Time Point	Group 1 (Mean±SD)	Group 2 (Mean±SD)	p-value
Baseline	2.13±0.13	2.17±0.16	0.423
3 Months	1.63±0.13	1.67±0.16	0.456
6 Months	1.13±0.13	1.17±0.16	0.467
3M Post-restoration	0.73±0.13	0.77±0.16	0.478

Table 4: Modified Plaque Index (Mpi)

Time Point	Group 1 (Mean±SD)	Group 2 (Mean±SD)	p-value
Baseline	1.84±0.14	1.87±0.17	0.570
3 Months	1.24±0.14	1.27±0.16	0.601
6 Months	0.74±0.13	0.77±0.17	0.612
3M Post-restoration	0.33±0.14	0.35±0.11	0.589
% Reduction	82.1%	81.3%	—

Table 5: Modified Bleeding Index (Mbi)

Time Point	Group 1 (Mean±SD)	Group 2 (Mean±SD)	p-value
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Baseline	1.64±0.14	1.67±0.16	0.567
3 Months	1.05±0.14	1.07±0.16	0.712
6 Months	0.55±0.13	0.57±0.17	0.723
3M Post-restoration	0.21±0.09	0.23±0.10	0.589
% Reduction	87.2%	86.2%	—

Table 6: Probing Depth (PD) and Clinical Attachment Loss (CAL)

Parameter	Group 1 (Mean±SD)	Group 2 (Mean±SD)	p-value
Mean PD (Baseline to 3M)	1.00±0.85 mm	0.80±0.77 mm	0.503
Mean PD (Baseline to 6M)	0.80±0.77 mm	0.67±0.72 mm	0.627
Mean CAL (Baseline to 3M)	1.00±0.85 mm	0.80±0.77 mm	0.503
Mean CAL (Baseline to 6M)	0.80±0.77 mm	0.67±0.72 mm	0.627

Table 7: Crestal Implant Marginal Bone Level (CIMS) at 6 Months

Parameter	Group 1: GTR+DFDBA	Group 2: PRFM+DFDBA
Mean CIMS Score	0.00±0.00	0.00±0.00
Implants with stable bone	15 (100%)	15 (100%)
Mean bone level change	0.00 mm	0.00 mm

Table 8: Summary of Overall Parameter Reductions

Parameter	Group 1 Improvement	Group 2 Improvement
FMpi (Baseline to 3M Post-restoration)	59.6%	59.0%
GI (Baseline to 3M Post-restoration)	65.7%	64.5%
Mbi (Baseline to 3M Post-restoration)	87.2%	86.2%

Discussion:

Immediate implant placement represents a paradigm shift in oral rehabilitation, reducing physiological trauma while maximizing aesthetic tissue preservation [12]. However, bone remodeling following immediate implant placement is inevitable and may compromise soft and hard tissue outcomes if the jumping distance is inadequately managed [13, 14]. The results of this randomized controlled trial demonstrate that employing a two-stage immediate implant protocol with DFDBA yields acceptable soft and hard tissue healing, with 100% implant survival and success rate across all 30 patients. DFDBA has been shown to serve as an exceptional osteoconductive matrix, maintaining the architecture of the alveolar bone and reducing bundle bone resorption that occurs at extraction sites [15]. The universal CIMS score of 0.00 across both groups at 6 months corroborates this. The equivalence observed between GTR membrane and PRFM as adjuncts to DFDBA is noteworthy. Although these modalities differ mechanistically - GTR working on the principle of cell exclusion [17] and PRFM providing sustained release of pro-angiogenic cytokines [18] - both equally supported the particulate graft in de novo bone formation. This aligns with recent literature reporting comparable clinical and radiographic improvements with both biological and membrane-based treatment modalities [16]. Limitations of this

study include a restricted sample size and a 3-month post-restoration follow-up period. Pink esthetic scores, patient-reported outcomes and cost-effectiveness analyses were not evaluated and should be addressed in future investigations.

Conclusion:

Immediate implant placement with a two-stage regenerative protocol provides predictable clinical, functional and radiographic outcomes. DFDBA with either GTR membrane or PRFM achieved 100% implant survival and success, with no significant differences between groups. Both regenerative adjuncts may be selected according to clinical preference, availability, and patient-specific factors.

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Conflict of interest: The authors declare no conflict of interest.

Ethical approval:

Ethical clearance was obtained from the Institutional Ethical Committee and Review Board, Maitri College of Dentistry and Research Centre (Ref: MCDRC/2024/APR/435 and MCDRC/2024/APR/434).

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