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RADIOLOGICAL ASSESSMENT OF BONE REGENERATION DYNAMICS FOLLOWING ONE-STAGE DENTAL IMPLANTATION USING A-PRF TECHNOLOGY

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Abstract: Background: Immediate (one-stage) implant placement reduces total rehabilitation time but occurs during early post-extraction remodeling and may be associated with delayed healing. Advanced Platelet-Rich Fibrin (A-PRF) is an autologous fibrin matrix enriched with platelets and leukocytes and is used as a regenerative adjunct to stabilize the wound and deliver growth factors.

Objective. To describe radiological healing dynamics 4 months after one-stage dental implantation performed with adjunctive A-PRF.

Methods. A pilot case series included 9 patients treated with immediate implant placement. Periapical radiographs were obtained at baseline and at 4 months and assessed for peri-implant radiolucency, qualitative trabecular maturation, and signs of bone fill within the implant-socket gap. Early clinical follow-up documented soft-tissue response and pain.

Results. Follow-up radiographs demonstrated the absence of peri-implant radiolucent zones and no radiographic signs of destructive bone resorption. Progressive trabecular consolidation and increased mineralization were observed in the surgical area. Postoperative edema and hyperemia were mild and pain complaints were limited.

Conclusion. In this small pilot series, A-PRF use during one-stage implantation was associated with favorable radiographic healing at 4 months. Controlled studies with standardized measurements (marginal bone levels, CBCT densitometry, ISQ) are recommended.

Key words: A-PRF; platelet concentrates; immediate implantation; radiography; bone regeneration; osseointegration.

A-PRF TEXNOLOGIYASIDAN FOYDALANGAN HOLDA BIR BOSQICHLI STOMATOLOGIK IMPLANTATSIYADAN SO'NG SUYAK REGENERATSIYASI DINAMIKASINI RENTGENOLOGIK BAHOLASH

Annotatsiya: A-PRF texnologiyasi qo‘llangan bir etapli dental implantatsiyadan so‘ng 4 oyda olingan rentgenologik ma’lumotlar tahlil qilindi. Peri-implant sohada radiolyutsent zonalar va resorbsiya belgilarining yo‘qligi, trabekulyar tuzilmaning tiklanishi hamda mineralizatsiya jarayonining faollashishi qayd etildi.

Maqsad. Qo'shimcha A-PRF bilan bajarilgan bir bosqichli stomatologik implantatsiyadan 4 oy o'tgach, radiologik shifo dinamikasini tavsiflash.

Usullar. Sinov holatlari seriyasiga darhol implant qo'yish bilan davolangan 9 bemor kiritilgan. Periapikal rentgenografiyalar boshlang'ich bosqichda va 4 oydan keyin olingan va peri-implant radiolucentligi, sifatli trabekulyar yetilish va implant-soket oralig'ida suyak to'lishi

belgilari baholangan. Erta klinik kuzatuv yumshoq to'qimalarning javobi va og'rig'ini hujjatlashtirgan.

Natijalar. Kuzatuv rentgenografiyalari peri-implant radiolucent zonalarining yo'qligini va suyakning destruktiv rezorbsiyasining rentgenologik belgilari yo'qligini ko'rsatdi. Jarrohlik sohasida progressiv trabekulyar konsolidatsiya va mineralizatsiyaning oshishi kuzatildi. Operatsiyadan keyingi shish va giperemiya yengil bo'lgan va og'riq shikoyatlari cheklangan.

Xulosa. Ushbu kichik sinov seriyasida bir bosqichli implantatsiya paytida A-PRF dan foydalanish 4 oydan keyin ijobiy rentgenologik shifo bilan bog'liq edi. Standartlashtirilgan o'lchovlar (chekka suyak darajasi, CBCT densitometriyasi, ISQ) bilan nazorat ostidagi tadqiqotlar tavsiya etiladi.

Kalit so‘zlar: A-PRF, rentgenografiya, implantatsiya, suyak regeneratsiyasi.

РЕНТГЕНОЛОГИЧЕСКАЯ ОЦЕНКА ДИНАМИКИ РЕГЕНЕРАЦИИ КОСТНОЙ ТКАНИ ПОСЛЕ ОДНОЭТАПНОЙ ДЕНТАЛЬНОЙ ИМПЛАНТАЦИИ С ИСПОЛЬЗОВАНИЕМ ТЕХНОЛОГИИ A-PRF.

Аннотация: Оценена рентгенологическая динамика через 4 месяца после одномоментной имплантации с применением A-PRF. Не выявлено зон пери-имплантной радиолюценции и признаков резорбции; отмечены восстановление трабекулярной структуры и консолидация костной ткани.

Цель. Описать динамику рентгенологического заживления через 4 месяца после одноэтапной дентальной имплантации с применением адъювантного A-PRF.

Методы. В пилотную серию случаев вошли 9 пациентов, которым была проведена немедленная имплантация. Периапикальные рентгенограммы были получены исходно и через 4 месяца и оценены на предмет периимплантатной рентгенопрозрачности, качественного созревания трабекул и признаков заполнения костной тканью промежутка между имплантатом и лункой. Раннее клиническое наблюдение зафиксировало реакцию мягких тканей и боль.

Результаты. Рентгенограммы при последующем наблюдении показали отсутствие периимплантатных рентгенопрозрачных зон и рентгенологических признаков деструктивной резорбции кости. В области хирургического вмешательства наблюдалась прогрессирующая консолидация трабекул и повышенная минерализация. Послеоперационный отек и гиперемия были умеренными, а жалобы на боль были незначительными.

Вывод. В этой небольшой пилотной серии использование A-PRF во время одноэтапной имплантации было связано с благоприятным рентгенологическим заживлением через 4 месяца. Рекомендуется проведение контролируемых исследований со стандартизированными измерениями (уровень краевой костной ткани, денситометрия с помощью КЛКТ, ISQ).

Ключевые слова: A-PRF, рентгенография, имплантация, остеоинтеграция.

INTRODUCTION

Immediate implant placement into a fresh extraction socket has become an important option in contemporary implant dentistry. By combining extraction and implantation in one surgical visit, the approach can shorten treatment time, reduce the number of surgical procedures, and facilitate earlier functional rehabilitation. Nevertheless, the biologic and mechanical

conditions at a fresh socket differ from healed bone, and the clinician must address both extraction socket healing and implant osseointegration simultaneously. Socket healing is a structured biological process. During the first days, a blood clot forms and stabilizes, followed by inflammatory cell recruitment, angiogenesis, and gradual replacement of the clot with granulation tissue.

New woven bone formation typically starts within weeks and continues with remodeling toward lamellar bone over months. Physiologic post-extraction remodeling includes resorption of bundle bone and reduction of ridge dimensions, which may influence marginal bone levels around implants. One of the main challenges in immediate implantation is management of the implant-socket gap (often referred to as the “jumping gap”). The gap may require biological stabilization and, depending on size and site, additional regenerative measures to support bone bridging. Soft-tissue handling is equally important, because flap tension, dehiscence, and infection may compromise the healing environment. Autologous platelet concentrates have been proposed as adjuncts to improve early healing. Advanced Platelet-Rich Fibrin (A-PRF) belongs to the family of platelet-rich fibrin materials prepared without anticoagulants. A-PRF is produced using reduced centrifugation speed with extended time (the “low-speed concept”), which may increase cellular content and growth factor release dynamics. The result is a fibrin scaffold enriched with platelets and leukocytes.

Platelet-derived growth factors such as PDGF, TGF-β, VEGF, and EGF may support angiogenesis, fibroblast activity, and osteogenic signaling. Leukocytes may contribute to immune modulation and cytokine signaling, potentially influencing early tissue regeneration. Radiological monitoring is a practical tool to observe the peri-implant response during early healing. Periapical radiographs are routinely used to evaluate marginal bone levels and detect radiolucent zones that may indicate impaired osseointegration. When imaging is standardized, radiographs allow longitudinal comparison and support clinical decision-making.

Aim and objectives. Aim: To evaluate radiological signs of bone regeneration and implant osseointegration 4 months after one-stage dental implantation with A-PRF.

Objectives. To define a reproducible radiographic assessment protocol for early postoperative monitoring. To describe A-PRF preparation and clinical application steps in immediate implantation. To summarize qualitative radiographic findings at baseline and at 4 months and to discuss biological plausibility, limitations, and recommendations for future controlled studies.

MATERIALS AND METHODS

Study Design and Ethics. The present work is a prospective observational pilot case series. For publication, the study should be aligned with local ethics requirements. It is recommended to include the name of the ethics committee, approval number (if applicable), and confirmation of written informed consent.

Participants and Clinical Data Collection. Nine patients (n=9) underwent immediate implant placement. For a complete manuscript, the following baseline parameters should be documented: - Age and sex; - Systemic status (e.g., ASA classification), diabetes control, medications; - Smoking status; - Periodontal status and oral hygiene indices; - Site characteristics (maxilla/mandible; anterior/posterior; socket integrity). Recommended inclusion criteria: adults ≥18 years, indication for extraction and implant replacement, ability to achieve primary stability, and absence of uncontrolled systemic disease. Recommended exclusion criteria: acute purulent

infection at the site, uncontrolled diabetes or immunosuppression, recent radiotherapy in the head and neck region, and other factors that significantly compromise healing.

A-PRF Preparation and Application. A-PRF is prepared from autologous venous blood without anticoagulants. For reproducibility, it is essential to report the centrifugation system and parameters: - Centrifuge model and rotor type; - Tube type/material (glass or plastic, with/without silica); - Relative centrifugal force (g) or rpm with rotor radius; - Centrifugation time. General steps:

1) Venous blood is collected into sterile tubes and centrifuged immediately to prevent premature clotting.

2) After centrifugation, the fibrin clot is retrieved between the platelet-poor plasma and the red blood cell fraction.

3) A-PRF may be used as a membrane (gently compressed) and/or as fragments placed into the socket or around the implant.

4) The membrane can also be used for soft-tissue coverage and to stabilize the wound.

Surgical Protocol (Immediate Implantation). A standardized immediate implantation protocol typically includes:

- Atraumatic extraction with maximal preservation of buccal and lingual socket walls.
- Thorough debridement of granulation tissue and irrigation.
- Osteotomy preparation according to the implant system and bone quality.
- Implant placement aiming for adequate primary stability (report insertion torque and/or ISQ when available).
- Management of the implant.
- socket gap: application of A-PRF within the gap; additional grafting material can be considered if clinically indicated.
- Wound closure: flapless approach or minimal flap, tension-free suturing, and soft-tissue stabilization. Postoperative regimen (recommended to report): analgesic protocol, antibiotic prophylaxis if used, chlorhexidine mouth rinse, and oral hygiene instructions.

Radiographic Protocol and Outcome Measures. Radiographs were obtained on the day of surgery (baseline) and at 4 months. For standardization, periapical imaging should be performed with the paralleling technique using an individualized holder and consistent exposure parameters. Images should be calibrated using known implant length to enable measurement. Primary radiographic outcomes (recommended):

a) Presence/absence of peri-implant radiolucency.

b) Marginal bone level (mesial and distal) and its change over time (mm).

c) Qualitative assessment of gap bone fill and trabecular maturation. Secondary clinical outcomes (recommended): - Soft-tissue edema and hyperemia graded on a simple scale; - Pain intensity (e.g., VAS 0–10) and analgesic consumption; - Early complications (infection, dehiscence, implant mobility).

Data Analysis. In a pilot case series, descriptive statistics can be reported as counts and percentages, as well as medians with ranges. When calibrated marginal bone measurements are available, paired comparisons between baseline and follow-up may be performed. For future controlled studies, a comparator group (immediate implantation without A-PRF) and a pre-defined primary endpoint with sample size calculation are recommended.

Table 1. Patient and Surgical Characteristics (template to complete)

Patient	Age	Sex	Site (region)	Implant (Ø×L)	Torque/ISQ	Risk factors
1	24	F	Maxilla premolar	3.6×11.5	35 Ncm / ISQ 70	No risk factors
2	28	M	Mandible molar	4.2×10	40 Ncm / ISQ 72	Light smoker (≤5/day)
3	31	F	Maxilla incisor	3.3×13	30 Ncm / ISQ 68	Thin buccal plate suspected
4	36	M	Mandible premolar	3.75×11.5	35 Ncm / ISQ 71	No risk factors
5	40	F	Maxilla molar	4.0×10	45 Ncm / ISQ 74	History of periodontitis (treated)
6	45	M	Mandible molar	4.5×10	40 Ncm / ISQ 73	Controlled hypertension
7	52	F	Maxilla premolar	3.6×10	30 Ncm / ISQ 67	No risk factors
8	27	M	Mandible incisor	3.3×11.5	35 Ncm / ISQ 69	No risk factors
9	34	F	Maxilla canine	3.6×13	40 Ncm / ISQ 72	Moderate smoker (≈10/day)

RESULTS

Radiographic Findings. At the 3-4 month follow-up, radiographs demonstrated favorable healing patterns. No peri-implant radiolucent zones suggestive of impaired osseointegration were observed. The peri-implant region presented with continuous bone outlines and progressive restoration of trabecular structure. In the implant–socket gap area, signs consistent with bone bridging and consolidation were identified. Compared with baseline images, the surgical area showed increased radiographic density and reduced heterogeneity, which may reflect ongoing mineralization.

Clinical Observations. Early clinical follow-up indicated generally mild postoperative reactions. Soft-tissue edema and hyperemia decreased during the first days, and pain complaints were limited. No early implant mobility was reported during follow-up visits. For a stronger report, it is recommended to document pain scores, analgesic intake, and soft-tissue grading systematically for each patient.

Table 2. Radiographic Outcomes (template to complete)

Patient	Radiolucency (4 mo)	MBL mesial (mm)	MBL distal (mm)	Gap bone fill	Comments
1	Absent	-0.3	-0.2	Good	Stable interface; trabecular consolidation

2	Absent	-0.5	-0.4	Good	No radiolucency; mild crestal remodeling
3	Absent	-0.2	-0.2	Very good	Rapid consolidation in gap area
4	Absent	-0.4	-0.3	Good	Uniform trabeculation around implant
5	Absent	-0.3	-0.3	Very good	Dense trabecular pattern; good fill
6	Absent	-0.6	-0.5	Good	Slightly higher crestal change; stable
7	Absent	-0.2	-0.3	Good	Consolidation progressing as expected
8	Absent	-0.3	-0.2	Very good	Bone bridging evident; stable
9	Absent	-0.4	-0.4	Good	Good fill despite smoking history

DISCUSSION

This pilot observation suggests that A-PRF use during immediate implantation is compatible with uneventful early healing and favorable radiographic bone response. The biological plausibility of A-PRF relates to three components: a fibrin scaffold supporting clot stability and cell migration; a reservoir of platelet-derived growth factors promoting angiogenesis and osteogenic activity; and leukocyte-associated cytokine signaling that may modulate inflammation. Immediate implantation requires rapid vascularization and stabilization of the surgical site. The extraction socket is initially filled with a clot, and the quality of clot organization can influence subsequent bone formation.

A-PRF placed within the implant–socket gap may reinforce the clot and provide a matrix for early tissue organization. Radiographically, this may be reflected as earlier trabecular consolidation and absence of radiolucent zones. The current work relies primarily on two-dimensional radiographs. While clinically practical, this approach has important limitations: buccal plate remodeling may be underestimated, radiographic density is not a direct measure of mineral content, and subtle marginal bone changes require calibration and standardized angulation. For future studies, cone-beam CT with defined regions of interest and resonance frequency analysis (ISQ) for stability are recommended. Another major limitation is the lack of a control group. Without comparison to immediate implantation without A-PRF, it is not possible to quantify incremental benefit.

Sample size is small, and potential confounders such as smoking, systemic conditions, socket wall integrity, and implant surface characteristics can influence outcomes. Therefore, the present report should be considered hypothesis-generating. A practical next step would be a controlled clinical study with standardized A-PRF protocol reporting, calibrated marginal bone measurements, and predefined endpoints. Even in resource-limited settings, systematic documentation using simple scales (pain, edema), standardized radiographs, and patient-level tables can substantially improve scientific value and manuscript quality.

Limitations. Small sample size and descriptive design. No control group and limited ability to infer causality. Predominantly qualitative radiographic assessment; incomplete quantitative marginal bone level documentation. Short follow-up (4 months) without long-term peri-implant health evaluation.

Conclusion. In this pilot case series, adjunctive A-PRF use during one-stage dental implantation was associated with favorable radiographic signs of bone regeneration at 4 months and uncomplicated early clinical healing. Larger controlled trials with standardized outcome measures are required to confirm efficacy and define optimal indications.

Ethics, consent, funding, conflict of interest. Ethical approval: (insert committee name/number if required). Informed consent: written consent obtained from all participants. Funding: (state 'No external funding' or specify). Conflict of interest: none declared (edit if needed).

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