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Immediate implant grafted with xenograft and hyaluronate verses xenograft and injectable platelet rich fibrin comparative study clinically and radiografically

Bdoor Salman Khairy ✉, **Ahmed Jassam Al-Naqeeb**

University of Anbar, College of Dentistry, Iraq

✉ bdoor.s.khairy@uoanbar.edu.iq

Abstract

INTRODUCTION. Immediate implant placement offers clinical advantages include shortened treatment duration and alveolar bone preservation.To improve soft tissue healing and osseointegration, adjunctive grafting materials are frequently utilized. AIM of this study was to compare the efficacy of gap filling materials (xenograft and hyaluronate versus xenograft and I-PRF) of immediate implant in maxillary anterior and premolar region.

MATERIALS AND METHODS. A total of 20 patient enrolled in this study. Dental implant placed following a traumatic tooth extraction .the patients divided equally in two group: group A (*n* = 10) received xenograft and hyaluronate. while group B (*n* = 10) received xenograft and I-PRF. Clinically, Implant stability was assessed immediately and after 6 months postoperatively using penguin ® RFA device. Radiographically, the assessment of marginal bone loss and buccal bone thickness ,immediately and six months after implant placement using CBCT.

RESULTS. All dental implant in both group were successfully ossteointergrated and functionally stable. Regarding implant stability, plalatal bone loss and buccal bone thickness not significant difference between the two group while buccal bone loss statically significant between them.

CONCLUSIONS. Both grafting materials effectively preserved the ridge dimensions and supported implant stability, but xenograft combined with HA showed a modest advantage in maintaining the buccal bone crest.

Keywords: immdiate implant ,xenograft ,I-PRF, hyaluronate

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Немедленная имплантация с ксенографтом и гиалронатом versus ксенографт и инъекционная тромбоцитарная плазма (I-PRF): сравнительное клиническое и рентгенологическое исследование

Б.С. Хайри ✉, **А.Д. Аль-Накееб**

Университет Анбара, Ирак

✉ bdoor.s.khairy@uoanbar.edu.iq

Резюме

ВВЕДЕНИЕ. Немедленная установка имплантатов обладает клиническими преимуществами, включая сокращение длительности лечения и сохранение альвеолярной кости. Для улучшения заживления мягких тканей и остеоинтеграции часто используются вспомогательные материалы для костной пластики.

ЦЕЛЬ. Целью данного исследования было сравнить эффективность материалов для заполнения костного дефекта (ксенографт и гиалронат versus ксенографт и I-PRF) при немедленной имплантации в переднем и премолярном сегменте верхней челюсти.

МАТЕРИАЛЫ И МЕТОДЫ. В исследование было включено 20 пациентов. Имплантаты устанавливали сразу после травматического удаления зуба. Пациенты были разделены на две группы: группа А (*n* = 10) получала ксенографт с гиалронатом, группа В (*n* = 10) – ксенографт с I-PRF. Клинически стабильность имплантатов оценивали немедленно и через 6 месяцев после операции с использованием устройства Penguin® RFA. Рентгенологически оценивали маргинальную потерю кости и толщину щечной кости сразу и через 6 месяцев после установки имплантата с помощью CBCT.

РЕЗУЛЬТАТЫ. Все имплантаты в обеих группах успешно остеоинтегрировались и были функционально стабильны. Что касается стабильности имплантатов, потери небной кости и толщины щечной кости, статистически значимых различий между группами не выявлено. При этом различия в потере щечной кости между группами были статистически значимыми.
ВЫВОДЫ. Оба материала для костной пластики эффективно сохраняют размеры альвеолярного гребня и поддерживают стабильность имплантатов, однако ксенографт в комбинации с гиалронатом показал небольшое преимущество в поддержании щечной кости.

Ключевые слова: немедленный имплантат, ксенографт, I-PRF, гиалронат

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INTRODUCTION

Immediate implant placement has become a favored treatment protocol by many clinicians worldwide because of its several clinical advantages outweighs the delayed implant placement because it preserves alveolar bone height and width, avoids a second surgery with an added advantage of less operator time. Furthermore, it results in less discomfort for the patient and minimizes tissue damage. Ultimately, it enhances the functionality and aesthetics of the individual [1; 2]. After the extraction, the alveolar socket often has a diameter that is greater than the implant; this leads to a gap between the implant surface and the alveolar bone walls at the recipient site. This gap was called “jumping distance” or the “peri-implant gap”. The peri-implant gap influences osseointegration and implant stability [3; 4]. Implants gain their immediate stability via their contact with the surrounding existing bone tissues. This is called primary stability. Primary stability is derived from the mechanical adaptation and is important because it gives the immediate support for the implants until secondary stability is obtained. At this point, there are still significant gaps at the bone-implant interface [5]. To improve osseointegration and avoid buccal plate resorption in an extracted socket, the gap between the implant and the socket must be filled with a biocompatible material, such as a graft [6]. Notably, xenografts have emerged as a popular option for bone grafting due to their widespread availability and ease of processing. Xenografts offer an osteoconductive framework and possess a mineral composition akin to that of human bone, facilitating integration with the host bone [7]. The use of bone substitutes in combination with blood derivatives has been shown to provide a synergistic effect in promoting tissue healing and regeneration. Among these blood products, platelet-rich fibrin standout for its osteogenic properties, due to the presence of growth and angiogenic factors. PRF is a second-generation platelet concentrate obtained entirely from autologous sources. It consists of an autologous fibrin matrix and has many advantages, such as simpler preparation and the absence of chemical alteration of the blood, rendering it a wholly autologous formulation. The I-PRF is one of the most developed. The I-PRF approach necessitates short centrifugation time to get concentrated liquid platelets and predominantly utilizes liquid thrombin and fibrinogen before fibrin formation occurs [8; 9]. Another promising adjunct is using osteogenic material like Hyaluronic acid (HA) Its biocompatibility, biodegradability, and nonimmunogenicity are all biological processes in relation to tissue healing and morphogenesis [10]. Its physicochemical characteristics also allow it to mediate osteoblast adhesion to the surface of the bone and retain osteoinductive growth factors in the local environment [11]. the aim of study is to compared the effectiveness of bovine xenograft combined Hyaluronate versus bovine xenograft combined with injectable platelet rich fibrin in augmenting peri-implant gaps around immediate dental implants placed in fresh extraction sockets.

MATERIALS AND METHODS

Study design

This prospective clinical comparative study was conducted at the Department of oral and Maxillofacial Surgery, College of Dentistry, University of Anbar and university of Tikrit, during the period from February 2025 to October 2025.The study sample included patients with conditions indicated for teeth extraction seeking dental implant treatment to replace single non-restorable teeth by means of immediate dental implant placement. The study protocol was approved by the scientific committee of University of Anbar, College of Dentistry with a (reference number:14 at 18.03.2025).

Study sample

A total of 20 patients,11 females and 9 male aged between 23–43 years were enrolled in this study, the patients were randomly assigned into two groups. group A and group B, receiving a total of 20 dental implants (Medintika ®, Germany), the implants inserted immediately in fresh extraction sockets and the gap between the sockets walls and implants surfaces were filled with xenograft bone grafting material combined with hyaluronate for group A, on the other hand an xenograft with injectable platelet rich fibrin (I-PRF) were used for group B.

Criteria for selection patient

All patients received simple explanation of the planned surgical procedure and the possibility of complications or even failure, and they sign an informed consent that documents all the verbal information and agreement.

Inclusion criteria

1. Patient aged ⩾ 18 years old.
2. Non-smokers or light smokers (< 10 cigarettes / day).
3. Patients with non-restorable single (incisors, canines and premolars advised for extraction.
4. A gap exceeding 2 mm around the immediate implant surfaces post-insertion.
5. Adequate bone volume for implant placement.
6. Patient's with good oral hygiene and periodontal health.

Exclusion criteria

1. Heavy smoking habits (> 20 cigarette / day).
2. Patients with Systemic conditions and diseases such as diabetes mellitus, immune disorders osteoporosis or disease that would interfere with good mucosal and bone healing.
3. Pregnant or lactating mothers.
4. Poor oral hygiene or active periodontal disease
5. Allergies to graft materials or hyaluronic acid.
6. History of radiotherapy or chemotherapy to the head and neck region within the last 12 months.
7. Patients with no or a gap of ⩽ 2 mm around the inserted dental implant.

Radiographical examination

All patients underwent a comprehensive preoperative radiographic CBCT, which provided a general assessment that included an overview of the dentition and both jaws, angulation of adjacent teeth, length of the root designated for extraction, thickness of the buccal plate, available bone height for implant placement, presence of any pathology, and proximity to vital anatomical structures such as the maxillary sinus, nasal cavity, and adjacent tooth root within the mandibular canal.

Surgical procedure

All procedures were done under local anesthesia, using local infiltration into the buccal and palate mucosa of the selected surgical area with lidocaine hydrochloride 2% (1.8 ml carpules with adrenaline 1:80,000) (Huons Co., Ltd., Korea). A traumatic extraction of the indicated tooth started with a sharp periotome, carefully employed to destroy the surrounding periodontal ligament attachments. Subsequently, the roots were retrieved using extraction forceps.

Debridement of the extraction socket was performed with a surgical curette to eliminate any residual soft tissue, periapical lesions, and granulation tissue, if present. The socket was washed out using copious saline irrigation. Implant osteotomy was prepared 2–3 mm beyond the apex by using pilot drill and sequential drilling until reaching the requested diameter, with an implant micromotor rotating at a speed of 800 rpm and 35 Ncm torque with copious saline irrigation. Implant was threaded into the bone using motorized method with the engine set at15 rpm and 35 Ncm torque, the implant fixture was placed 1–2 mm below the crest of alveolar ridge to compensate for future ridge resoption, and completion of insertion was done by the ratchet holder of the fixture.

Immediately following implant insertion, the primary stability was assessed using a Penguin RFA device (Integration diagnostic Ltd. Goteborgssvagen, Sweden). The Smart Peg was connected to the smart peg mount then it was screwed onto the implant, the Penguin RFA probe was held approximately 2–3 mm from the Smart-Peg at a right angle to obtain measurements in two directions (buccolingual and mesiodistal), the ISQ value of each fixture represented by the mean of both readings. A cover screw was placed after removing smartpeg.

The peri-implant gap was filled with bone graft according to the treatment group. In group A a xenogenic bovine bone graft with hyaluronate, Cerabone Plus® (Botiss Biomaterials GmbH, Germany) was used. while Group B received Cerabone ® (Botiss Biomaterials GmbH, Germany) with I-PRF. After graft placement, a resorbable collagen membrane was trimmed and adapted over the graft for both group and then the sits closed with nonresorable nylon sutures material (4/0) using interrupted technique.

I-PRF preparation

About 5 mL of autologous blood was collected from from each patient in the i-PRF group before initiating the surgical incision (after giving local anesthesia. from the median cubical vein (forearm) using 5 c.c. sterile disposable syringe. The collected blood was immediately moved to empty plastic tube without any anticoagulant, directly centrifuged for 3 minutes at 700 Rpm at room temperature. yellow-colored liquid layer form I-PRF was then achieved on Top of the tube and the red blood cells (RBCs) sedimented at the bottom. Subsequently, the I-PRF liquid form was collected carefully from the tube by a sterile Plastic Syringe.

Postoperative assessment

Stability evaluation

Immediately following implant insertion, the Stability was measured and Six months later, all the implants were exposed via the removal of the overlaying soft using tissue punch. Healing abutments were placed to the tissue, and after ten days, a penguin® RFA device was utilized to assess secondary stability following osseointegration, in a similar way as measured previously for the primary one the patient.

Radiographic evaluation

All patients were examined immediately on the same day of surgical procedure through CBCT and after 24 weeks to assess:

1. The marginal bone loss. The implant served as a reference for measuring marginal bone loss (MBL) from the cross-sectional view by aligning the panoramic long axis at its center and bisecting it (illustrating the buccolingual dimensions). A line was drawn parallel to the implant at the crest of the buccal plate of bone, exten-

ding to the apical level of the implant, and its height was measured in millimeters immediately and six months postoperatively. Radiographic MBL was determined by subtracting the baseline value from the measurements taken at 6 months postoperative. The identical procedure was repeated from the palatal side.

2. Changes in buccal bone thickness. A perpendicular horizontal measurement was taken from the implant crest to the buccal bone plate immediately after the operation. This measurement serves as a baseline. A same measurement was performed 6 months postoperatively and subtracted from the baseline value to ascertain horizontal bone loss.

Statistical analysis

All statistical analyses were performed using SPSS software, version 28. Data normality was assessed using the Shapiro–Wilk test to determine the suitability of parametric testing. The paired samples t-test was applied to evaluate intragroup differences between immediate and six-month follow-up measurements within each material group (HA and I-PRF). The independent samples t-test was used to compare mean values between the two materials at corresponding time intervals. All results were expressed as mean ± standard deviation (SD), and statistical significance was considered at a p-value < 0.05.

RESULTS

Demographic data

A total of 20 patients, 11 females and 9 males having maxillary non restorable teeth indicated for extraction and immediate implant placement were included in this study. Their ages ranged from 23 to 43 years with the mean age of patients in was 32.57 ± 5.7 years. All patients were followed up for 6 months The results were registered as regards clinical and radiographic variables.

Implant stability

As shown in Table 1 and Fig. 1, the mean and standard deviation of primary and secondary ISQ value of implant within group A (72.60 ± 7.79) ISQ and (85.20 ± 3.61) ISQ respectively. The difference between primary and secondary stability value in group A was statically significant (p = 0.020). Regarding group B, the mean and standard deviation of primary and secondary ISQ value of implant were (67.20 ± 10.43) ISQ and (82.20 ± 3.94) ISQ respectively. The difference between primary and secondary after six-month stability value in group B was statically significant as well as (p < 0.001). when comparing both group regarding the primary and secondary stability after six month the difference not statically significant (p = 0.206 and p = 0.093) respectively.

Marginal bone loss

A bone loss changes was evaluated according to each material. Regarding buccal bone loss, there was significant difference between HA group and I-PRF group after six months postoperatively (p = 0.027). Regarding palatal bone loss, there was no significant difference between study groups after 6 months (p = 0.095). As shown in Table 2.

Table 1. Comparison of implant stability (ISQ) values within the same group and between the two groups for HA and I-PRF materials

Таблица 1. Сравнение значений стабильности имплантата (ISQ) внутри одной группы и между двумя группами для материалов HA и I-PRF

Time	Mean ± S.D.		p-value (between groups)
	HA	I-PRF	
Immediate	72.60 ± 7.79	67.20 ± 10.43	0.206
After 6 Months	85.20 ± 3.61	82.20 ± 3.94	0.093
p-value (within each groups)	0.020*	< 0.001**	–

Note. * Significant (p < 0.05); ** High significant (p < 0.001)
Примечание. * Значимо (p < 0,05); ** высокозначимо (p < 0,001)

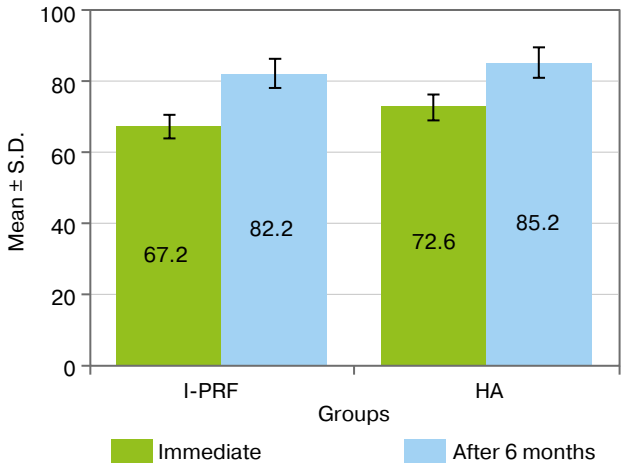

Fig. 1. Mean Stability (Mean ± SD) for Immediate and Six-Month Measurements in HA and I-PRF Groups

Рис. 1. Средняя стабильность (среднее ± стандартное отклонение) при немедленных и шестимесячных измерениях в группах HA и I-PRF

Table 2. Comparison between two study groups according to marginal bone loss after six months

Таблица 2. Сравнение двух исследуемых групп по величине маргинальной потери костной ткани через шесть месяцев

Materials	Mean ± S.D.		p-value (between groups)
	HA	I-PRF	
Buccal bone loss after six months	0.42 ± 0.24	0.75 ± 0.36	0.027*
Palatal bone loss after six months	0.89 ± 0.66	0.66 ± 0.34	0.095^{NS}

Note. * Significant difference between groups (p < 0.05); ^{NS} No significant difference between groups (p > 0.05)
Примечание. * Значимая разница между группами (p < 0,05); ^{NS} значимой разницы между группами нет (p > 0,05)

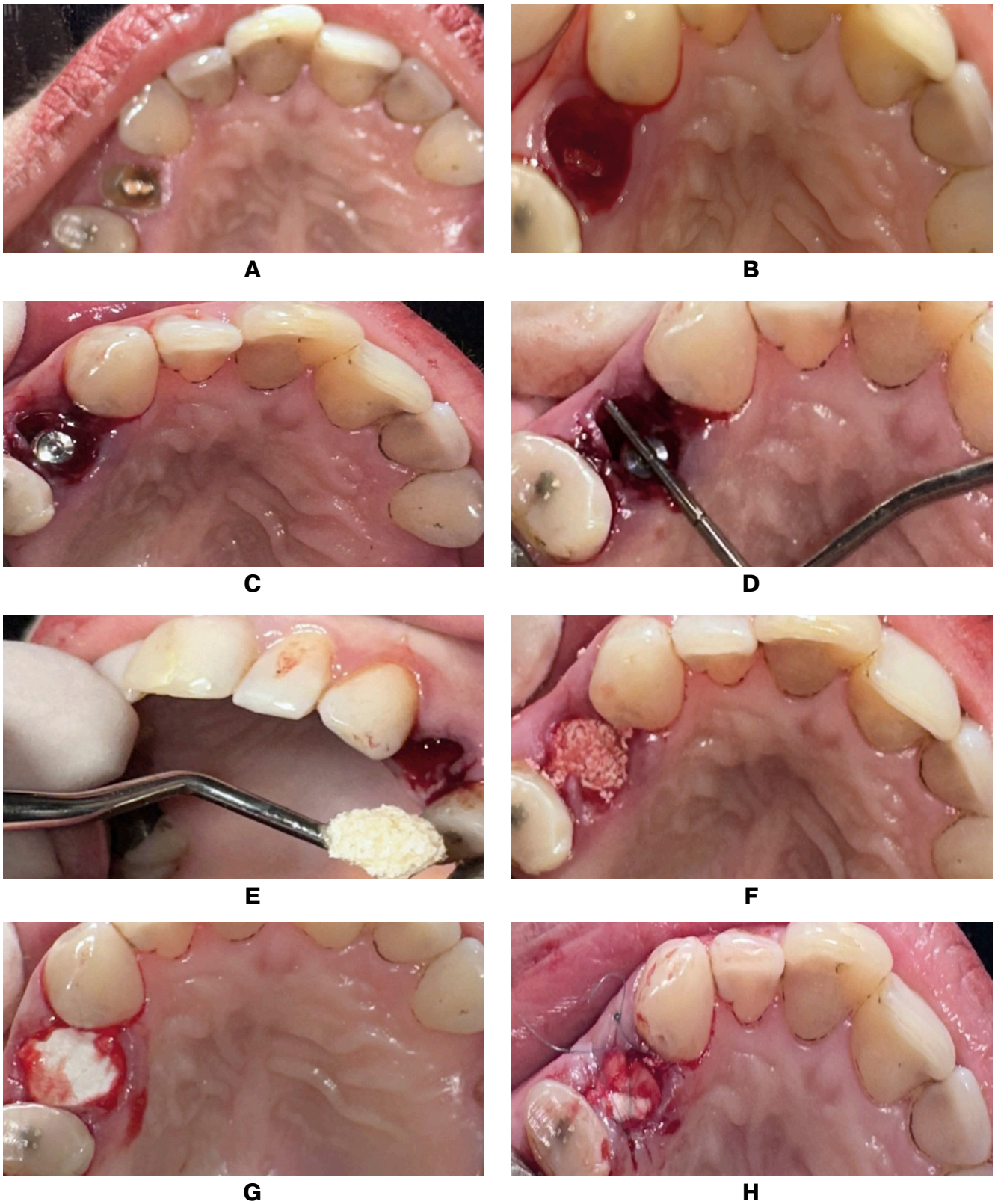

Fig. 2. Case presentation: *A* – non-restorable upper right premolar; *B* – socket after tooth extraction; *C* – implant fixture in place; *D* – measuring of the per implant gap with periodontal probe; *E* – xenograft with hyaluronate (sticky bone); *F* – the horizontal gap filled with bone graft; *G* – application the collagen membrane; *H* – primary closer of the socket

Рис. 2. Презентация клинического случая: *A* – не подлежащий восстановлению правый верхний премоляр; *B* – лунка после удаления зуба; *C* – установка имплантата на место; *D* – измерение периметра вокруг имплантата с помощью пародонтального зонда; *E* – ксенографт с гиалронатом (sticky bone); *F* – заполнение горизонтального промежутка костным трансплантатом; *G* – наложение коллагеновой мембраны; *H* – первичное закрытие лунки

Change in buccal bone thickness

Bone loss changes was evaluated according to each material. Regarding buccal bone thickness changes there not significant difference between HA group and I-PRF group after six-month postoperative (p = 0.135) as shown in Table 3.

Table 3. Change of buccal bone thickness after six-month

Таблица 3. Изменение толщины щечной кости через шесть месяцев

Indicator	Mean ± S.D.		*p*-value
	HA	I-PRF	
Chang of buccal bone thickness	0.220±0.103	0.440±0.432	0.135^{NS}

Note. ^{NS} Nonsignificant difference between groups ($p > 0.05$)
Примечание. ^{NS} статистически незначимая разница между группами ($p > 0,05$).

DISCCUSION

The placement of implants following extraction has emerged as a preferred treatment procedure due to the presence of rich periodontal cells and matrix in the natural socket, which promotes rapid healing and reduces the risk of bone necrosis. Furthermore, it eradicates the waiting period for socket ossification, necessitates fewer surgical sessions, shortens the edentulous period, reduces total costs, preserves alveolar bone height and width, and reduces operative time while causing less trauma to the tissues and reducing discomfort for the patient [12]. After the placing of implants into freshly extracted sockets, it is common for gaps to be present between the implants and the adjacent bone walls. The "jumping gap" is crucial for achieving adequate bone fill and stability surrounding the implant. Multiple approaches and grafting materials have been suggested to enhance this area. Xenograft possesses osteoconductive characteristics that facilitate bone regeneration in peri-implant bone restoration and alveolar ridge augmentation [13]. However, it is biologically inert, indicating that it serves as a scaffold with a minimal tendency for resorption [14]. Consequently, researchers and practitioners initiated the bio-activation of inert biomaterials using various biological adjuncts, including hyaluronic acid, platelet-rich fibrin, enamel matrix derivatives or others [15]. This study aims to examine the efficacy of I-PRF and HA with xenografts along with immediate implant placement in fresh extraction sockets.

In the current study, the stability of the implant, primary and secondary (six-month postoperative) was evaluated using resonance frequency analysis (RFA) Technique provided by penguin® device. The RFA method offer valuable mean of measuring osseointegration [16]. The result show improvement in ISQ values between the immediate and six-month measurements and statistically significant within both groups (I-PRF: $p < 0.001$; HA: $p = 0.020$). These findings indicate that both HA and I-PRF can enhance the biological environment at the implant–bone interface, promoting secondary stability and osseointegration. The improved ISQ values over time are consistent with Po-Sung Fu et al., who reported a progressive increase in the mean Implant Stability Quotient (ISQ) over time for all implants implanted immediately, both with and without provisionalization [17]. This also aligns with the results of Hassanan & El Naas et al., reported that the use of Injectable Platelet Rich Fibrin with xenogeaft around the immediate dental implants may be able to increase and improve healing around dental implants by the anti-inflammatory and antibacterial properties and increase the success rate of dental implants by increase the bone density and stability of dental implant [18].

An implant is deemed successful if the average bone loss does not exceed 1.5 mm in the first year post loading [19]. The present study showed a significant difference in buccal bone loss between the HA and I-PRF groups after six months (p = 0.027), whereas palatal bone loss did not differ significantly (p = 0.095). More Buccal bone loss was noted in the I-PRF group compared to the other group, indicating that the augmentation of the gap with Xenograft and HA resulted in a superior coronal position of the alveolar bone crest than that found in the I-PRF group. Nonetheless, the noted differences stayed within clinically acceptable limits (<1 mm). The present findings are in agreement with those of Abaza et al., who reported The using combination of HA with xenograft demonstrated in socket augmentation superior outcome in preservation bone dimension compared to xenograft alone or combined with I-PRF [20].

Regarding buccal bone thickness change was not statically significant between the two group. This finding suggests both hyaluronic acid and I-PRF with xenograft similarity positive effective in minimal loss of buccal bone thickness. The absence of a significant difference may be ascribed to the synergistic mechanisms of both materials in facilitating bone healing. The Hyaluronic acid hastened the formation of new bone by facilitating the differentiation of mesenchymal cells when combined with xenograft for regeneration of alveolar defects [21; 22]. Also, I-PRF facilitates osteogenesis via many mechanisms. It promotes the migration, adhesion, proliferation, and differentiation of osteoplastic cells, resulting in bone tissue production [23].

THE STUDY'S LIMITATION

The primary limitation of the current study is its sample size, which may constrain statistical power in identifying smaller intergroup differences. Additionally, the analysis was limited to a six-month follow-up period; prolonged assessments with loading the implant are necessary to determine if the identified differences persist or stabilize over time.

CONCLUSION

Both xenograft combination provided effective in reduce marginal bone loss and increase implant stability in immediate implant protocols. However, the combination of the haylronta with xenograft show slightly superior in implant stability and preservation per-implant bone dimension.

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INFORMATION ABOUT THE AUTHORS

Bdoor Salman Khairy Alhadithy – Master Student of Oral Surgery at University of Anbar, College of Dentistry, Anbar, Iraq; https://orcid.org/0009-0003-4725-2651

Ahmed Jassam Mohammed Al-Naqeeb – Lecturer at University of Anbar, College of Dentistry, Department of Oral and Maxillofacial Surgery, Anbar, Iraq; https://orcid.org/0000-0001-7964-6063

ИНФОРМАЦИЯ ОБ АВТОРАХ

Бдор Салман Хайри – магистрант кафедры челюстно-лицевой хирургии, стоматологический факультет, Университет Анбара, Анбар, Ирак; https://orcid.org/0009-0003-4725-2651

Аль-Накееб, Ахмед Джассам – преподаватель кафедры челюстно-лицевой хирургии, стоматологический факультет, Университет Анбара, Анбар, Ирак; https://orcid.org/0000-0001-7964-6063

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