RESEARCH PAPER

Incidence of post-operative complications following Immediate VS Delayed Implant Placement in Fresh Extraction Sockets: A Retrospective Analysis

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ABSTRACT

Background: Over the past 40 years, dental implantology has progressed significantly in its development and there is still a debate that continues about the timing for the implant placement after tooth extraction. Immediate implant placement (IIP) provides benefits in terms of biological and patient comfort, but a number of issues remain with respect to the complication profile of IIP versus delayed implant placement (DIP).

Aim: To find out whether there was a difference in post-operative complications and implant survival between patients who received an immediate implant versus a delayed implant in a fresh extraction site.

Hypothesis: To determine if there was a difference between the incidence of post-operative complications and implant survival between immediate and delayed implants in fresh extraction sockets.

Methods: The records of 128 patients (64 immediate and 64 delayed) who underwent a total of 144 dental implants from January 2021 to December 2023 were analysed in a retrospective comparative study performed at a tertiary dental centre. The outcome measures were post- operative infection, peri-implant mucositis, implant mobility or failure, marginal bone loss, pain and/or swelling that persisted during the post-operative period, and soft tissue dehiscence. The viability of the implants was evaluated at 3, 6, 12 and 18 months. Data were analysed in SPSS version 26.0 and Chi-Square test and Independent-samples t-test were used, and a p-value of <
0.05 was considered statistically significant.

Results: Overall complication rates were 33.3% in Group A and 23.6% in Group B (OR 1.61, 95% CI 0.77–3.34; p = 0.202). None of the individual complication categories were statistically significant. Implant survival at 18 months was 91.7% for Group A and 94.4% for Group B (p = 0.428). After one year (12 months) and two years (18 months), there was a significant difference between the groups in marginal bone loss (p = 0.007 and p = 0.014, respectively). The stability quotient of the implants at loading was significantly higher in Group B (72.1 ± 5.8 vs 67.4 ± 6.2; p<0.001).
Conclusions: The rates of complications and survival were clinically acceptable and statistically similar between immediate and delayed implant placement protocols after 18-months follow-up. Though delayed placement showed slightly better marginal bone preservation and primary stability, both techniques could be considered depending on site-specific factors and patients' characteristics. Further prospective, random controlled trials with longer duration of follow-up are warranted.

Keywords: Immediate implant placement; delayed implant placement; fresh extraction socket; post-operative complications; peri-implant mucositis; osseointegration; implant survival; marginal bone loss

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1. INTRODUCTION

The field of prosthetic dentistry has undergone a revolution over the past 40 years since the pioneering work of Brånemark and his colleagues[2,3] with the introduction of osseointegrated dental implants, from a purely submerged, delayed loading approach to more biologically dynamic treatments such as immediate and early implant placement in fresh extraction sockets. This development has been motivated by the need to shorten the total treatment time, decrease the number of surgical procedures and exploit the potential for enhancement of the alveolar bone during the peri-extraction period.

Each protocol offers specific clinical benefits and biological compromises that should be considered for each patient based on their systemic status, local bone morphology, soft tissue phenotype, and the esthetic expectations.[3,5]

The main biological argument for immediate implant placement (IIP) is the preservation of the alveolar ridge dimensions through the use of the socket as a natural guide to the location of the implant. The buccal plate, consisting almost exclusively of bundle bone, is especially affected by volumetric reduction, and mean horizontal bone loss of ~3.79 mm and vertical of 1.24 mm have been reported at 6 months after tooth extraction.

Delayed implant placement (DIP), on the other hand, lets the extraction site completely or nearly completely heal prior to surgical intervention. This has theoretically the advantage of creating a more predictable implant bed, increases the primary stability of the implant, and minimizes the risk of buccal fenestration or dehiscence.[22,23] The disadvantages are longer treatment time, unavoidable alveolar bone resorption over the healing period and the need for ridge augmentation in patients with extensive bone loss.[33,48]

Complication rate following implant surgery is a multi-faceted phenomenon, depending on patient-related factors (e.g. smoking, systemic disease, immune competence, oral hygiene), surgical-related factors (e.g. flap design, implant geometry,

insertion torque, gap between the implant surface and the socket wall) and prosthetic-related factors (e.g. loading time, type of loading).[10,12,14,32] The most common early complications are infection and peri-implant mucositis, while implant failure, marginal bone loss, and peri-implantitis are the most common long-term complications.[38,39]

Despite this evidence, most of the well-designed studies have been performed in western populations and most of the well-designed studies have focused on anterior maxillary implants; few studies have focused on mixed dentition posterior and anterior sites in South Asian populations.

Moreover, the majority of the published studies on the aetiology of tooth loss in India and the Indian sub-continental countries are retrospective, with small samples, limited follow-up time, no standardisation of the definitions of complications, and conflicting confounding factors such as smoking and diabetes.[25,26]

The aim of the present study was therefore to fill this void by comparing the incidence of post-operative complications and implant survival rates in patients who had immediate implant placement with those who had delayed implant placement in a tertiary dental care institution in the northern part of India, followed for a minimum of 18 months.

2. MATERIALS AND METHODS

2.1 Study Design

This was a single centre retrospective comparative cohort study, conducted following STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for observational studies. The department of oral and maxillofacial surgery dental records of patients treated in IMS, Lucknow from January 2021 to December 2023 was reviewed.

at least 18 years; (ii) Patients with at least one single or multiple tooth loss requiring implant-supported prosthetic rehabilitation;
(iii) Patients treated with IIP or DIP from

2.2 Ethical Approval

The study has been approved by the Institutional Ethics Committee (IEC/IDS/2024/078) of Institute of Dental Sciences, Lucknow with date of approval as 15-01-2024. The study was performed in accordance with the principles of the declaration on Helsinki (revised 2013). The ethics committee waived the need for individual informed consent because the study was conducted in a retrospective manner on de-identified patient records. Anonymity and confidentiality of patients and data were ensured during the study.

2.3 Study Setting

The study was carried out in the department of Oral and Maxillofacial Surgery, Institute of Dental Sciences, Lucknow which is a tertiary dental care and academic centre. Surgery was done by postgraduate-trained specialist OMF surgeons following standardised protocols.

2.4 Sample Size

The sample size was determined by using the published percentages of overall post-operative complications for both immediate implant placement (approximately 30–35%) and delayed implant placement (approximately 15–20%) with two-proportion z-test formula at a significance level of 5% ($\alpha = 0.05$) and statistical power of 80% ($\beta = 0.20$). A minimum sample of 58 patients per group was calculated and 64 patients per group were enrolled to accommodate 10% attrition resulting in a total sample size of 128 patients.

2.5 Inclusion Criteria

The following criteria were applied for inclusion of the patients: (i) Patients aged January 2021 to December 2023 in the study institution; (iv) patients with at least 18 months of follow-up data; (v) patients with ASA Physical Status Classification I or II;

(vi) minimum residual alveolar bone height of 8 mm and width of 5 mm confirmed by the Cone-beam computed tomography (CBCT) of the implant site; and (vii) regular follow- up visits.

2.6 Exclusion Criteria

Patients were excluded if they had: (i) active or chronic uncontrolled systemic diseases (uncontrolled diabetes mellitus (HbA1c>7.5%), haematological disorders); (ii) history of radiation therapy to the head and neck region; (iii) history of bisphosphonate or anti-resorptive drug therapy; (iv) history of inadequate treatment of adjacent teeth with a history of acute periapical or pericoronitis infection at the time of implant placement (applicable to Group A); (v) heavy smoking (>20 cigarettes/day); (vi) incomplete or illegible medical/dental records; and (viii) extensive bone augmentation procedures (guided bone regeneration (GBR) with a membrane not limited to the implant shoulder extending more than 3 mm, sinus floor elevation, or ridge splitting).

2.7 Group Allocation

It classified the eligible patients into two groups based on the time interval between implant placement and the removal of their tooth: Group A: Immediate Implant Placement (IIP): Implant placed in the same surgical session as tooth extraction (Type 1: within 24 hours after extraction). Group B (Delayed Implant Placement (DIP) – Implant placed after complete osseous socket healing (radiographically and clinically) at 4-6 months after extraction.

2.8 Surgical Protocol

Patients were treated according to a standardised pre-surgical protocol which included full-mouth professional scaling and root planing, oral hygiene instructions, and radiographic evaluation (OPG, CBCT) as well as systemic screening. Pre-operative chlorhexidine 0.2% mouthwash was given for 60 seconds immediately prior to the procedure; the antibiotic prophylaxis consisted of amoxicillin 2 g PO 1 h prior to surgery or, if the patient was allergic to penicillin, clindamycin 600 mg PO 1 h prior to surgery and continued for the subsequent 5 days.28

Atraumatic extraction was carried out under local anaesthetic (2% lignocaine with 1:80,000 adrenaline) of all the teeth of Group A (IIP) by using periotomes and microelevators. A curette was used to carefully debride the socket and saline was flushed into it. To ensure primary stability, the preparation of the sequential osteotomies was performed at the palatal or lingual wall of the socket, engaging native bone apical and lateral to the socket. If necessary, a gap of ≤ 2 mm between the implant surface and the socket wall was treated with deproteinised bovine bone mineral (DBBM; Bio-Oss®, Geistlich, Switzerland) and a collagen membrane (Bio-Gide®, Geistlich, Switzerland). Primary closure was performed with the use of 4-0 polyglycolic acid suture material tension-free vertical mattress sutures.

In Group B (DIP), a complete osseous healing was confirmed at 4-6 months following the extraction (CBCT and probing) and a standard crestal incision with mesial and distal releasing incisions was performed under local anaesthetic. All osteotomies were prepared according to manufacturer's- directed drilling and the implant was inserted at the manufacturer's recommended insertion torque. The closure was effected, as in Group A.

2.9 Implant Systems

In the study all implants used were two-piece, titanium alloy (grade 4 or 5 Ti-6Al-4V), surface sand blasted and acid etched (SLA or SLActive) endosseous dental implants. The implants consisted of Straumann® Standard Plus (Straumann Group, Basel, Switzerland), BioHorizons® Tapered Internal (BioHorizons, Birmingham, USA) and MIS® Seven (MIS Implants Technologies, Shlomi, Israel). All implants were platform-

switched abutments and the diameter ranged from 3.3 to 5.0 mm and the length from 8.0 to 14.0 mm.

2.10 Outcome Measures

The following post-operative complications were noted and compared between the two groups at each recall (1 week, 1 month, 3, 6, 12 and 18 months): (i) Post-operative infection – presence of purulent exudate, localised swelling with erythema and/or fever that required antibiotic adjustment or surgical drainage; (ii) Peri- implant mucositis – defined as the presence of bleeding on probing but no MBL, as per 2017 EFP/AAP classification;39 (iii) Implant mobility/failure – any clinical movement of the implant body, which is defined as total failure requiring explantation; (iv) MBL – radiographic measurement of the change in bone level from a standardised periapical radiograph at the time implant placement compared to recall visits using the implant-abutment junction as the reference point; (v) Persistent pain and/or swelling – persisting pain (VAS ≥ 4) on probing and/or discernible soft tissue swelling beyond 2 weeks post-surgery; (vi) Soft tissue dehiscence – exposure of implant surface or collar by loss of soft tissue from the surrounding area. Survival of the implant was considered to be if the implant was in place, in use and not determined to be failed, even if there were biological or prosthetic complications. This definition complies with the modified Albrektsson criteria for implant success and survival.

2.11 Implant Stability Measurement

The stability of the implants was evaluated by the resonance frequency analysis (RFA) with the Osstell® ISQ device (Osstell AB, Gothenburg, Sweden), at the time of implant placement and at the loading appointment (3–4 months after implant placement for Group B and 3–4 months for Group A). Implant stability quotient (ISQ) values were taken.

2.12 Statistical Analysis

IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, New York, USA) was used for all statistical analyses. Data for continuous variables were presented as mean ± SD and the differences between groups were tested for normality by Shapiro-Wilk test and compared by independent-samples t-test. Absolute numbers and percentages were used to present the categorical variables and compared using the Pearson chi-square test or Fisher's exact test, as appropriate. Odds ratios (OR) with 95% confidence intervals (CI) were calculated for dichotomous complication outcomes. Cumulative survival rates were used to represent the implant survival. In all analyses, a p value of < 0.05 was taken as statistically significant. No imputation was done for missing data, rather complete case analysis was used.

3. RESULTS:

3.1 Demographic and Clinical Characteristics

The total number of patients studied were 128 (72 male, 56 female), with a mean age of 38.8 ± 9.9 years. The mean ages of patients in Groups A and B were 38.4 ± 9.7 years and 39.1 ± 10.2 years, respectively. There was no difference between the two groups for age (P = 0.683), male/female ratio (P = 0.719), smoking status (P = 0.814), controlled diabetes (P = 0.771), ASA classification (P = 0.830), and mean follow-up duration (P = 0.491). The results indicate that there are no demographic differences between the two groups, as shown in Table 1.

Table 1: Demographic and Clinical Characteristics of Study Groups

Variable	Group A: Immediate (n = 64)	Group B: Delayed (n = 64)	p-value	Significance
Mean Age (years ± SD)	38.4 ± 9.7	39.1 ± 10.2	0.683	NS
Sex: Male	34 (53.1%)	36 (56.3%)	0.719	NS
Sex: Female	30 (46.9%)	28 (43.7%)		
Smokers	12 (18.8%)	11 (17.2%)	0.814	NS
Diabetic	6 (9.4%)	7 (10.9%)	0.771	NS
ASA Class I	51 (79.7%)	50 (78.1%)	0.830	NS
ASA Class II	13 (20.3%)	14 (21.9%)		
Mean Follow-up (months ± SD)	18.3 ± 3.1	17.9 ± 3.4	0.491	NS

NS = Not Significant; SD = Standard Deviation; ASA = American Society of Anesthesiologists.

3.2 Implant Site Distribution

In both groups a total of 144 implants were inserted (72 per group). The number of jaw regions did not significantly differ between groups (Table 2). The most common implant location in Group A was the maxillary anterior region (33.3%) and in Group B was the maxillary posterior region (30.6%).

Table 2: Implant Site Distribution by Jaw Region

Implant Site	Group A (n = 72 implants)	Group B (n = 72 implants)	Total	p-value
Maxillary Anterior	24 (33.3%)	18 (25.0%)	42 (29.2%)	0.287
Maxillary Posterior	18 (25.0%)	22 (30.6%)	40 (27.8%)	0.452
Mandibular Anterior	12 (16.7%)	14 (19.4%)	26 (18.1%)	0.670
Mandibular Posterior	18 (25.0%)	18 (25.0%)	36 (25.0%)	1.000
Total	**72 (100%)**	**72 (100%)**	**144 (100%)**	—

3.3 Post-Operative Complications

The overall complication rate was 33.3% (24/72 implants) in both Group A and 23.6% (17/72 implants) in Group B. This difference did not reach statistical significance (OR 1.61, 95% CI 0.77–3.34; p = 0.202). The individual complications are discussed in detail in Table 3.

Table 3: Comparison of Post-Operative Complications Between Groups

Complication	Group A Immediate n=72 (%)	Group B Delayed n=72 (%)	Odds Ratio (95% CI)	p-value	Sig.
Post-op Infection	9 (12.5%)	5 (6.9%)	1.91 (0.62–5.89)	0.254	NS
Peri-implant Mucositis	14 (19.4%)	8 (11.1%)	1.94 (0.77–4.89)	0.163	NS
Implant Mobility / Failure	5 (6.9%)	2 (2.8%)	2.59 (0.49–13.80)	0.256	NS
Marginal Bone Loss > 1 mm	11 (15.3%)	7 (9.7%)	1.68 (0.62–4.54)	0.307	NS
Persistent Pain / Swelling	8 (11.1%)	4 (5.6%)	2.13 (0.62–7.27)	0.227	NS
Soft Tissue Dehiscence	7 (9.7%)	3 (4.2%)	2.48 (0.62–9.90)	0.197	NS
Any Complication	24 (33.3%)	17 (23.6%)	1.61 (0.77–3.34)	0.202	NS

**p < 0.05 considered statistically significant. NS = Not Significant; OR = Odds Ratio; CI = Confidence Interval.*

Post-operative infection was recorded in 9 implants (12.5%) in Group A and 5 implants (6.9%) in Group B (OR 1.91, 95% CI 0.62–5.89; p = 0.254). Peri-implant mucositis was found to be the most common complication in both groups, with 14 (19.4%) and 8 (11.1%) implants affected in Groups A and B, respectively (OR 1.94, 95% CI 0.77–4.89; p = 0.163). Implant mobility requiring explantation occurred in 5 cases (6.9%) in Group A and 2 cases (2.8%) in Group B (OR 2.59, 95% CI 0.49–13.80; p = 0.256). Soft tissue dehiscence was observed in 7 implants (9.7%) in Group A versus 3 implants (4.2%) in Group B (OR 2.48, 95% CI 0.62–9.90; p = 0.197). All the complications were numerically higher in Group A but failed to reach statistical significance.

3.4 Implant Survival Rates

The cumulative implant survival rates at 3, 6, 12 and 18 months are shown in Table 4. There was no difference in implant survival at any time point. At 18 months, Group A demonstrated a survival rate of 91.7% and Group B 94.4% (p = 0.428).

Table 4: Cumulative Implant Survival Rates at Follow-up Intervals

Follow-up Period	Group A Immediate (%)	Group B Delayed (%)	Difference (95% CI)	p-value	Sig.
3 months	95.8%	97.2%	-1.4% (-6.9 to 4.1)	0.627	NS
6 months	94.4%	95.8%	-1.4% (-7.4 to 4.6)	0.641	NS
12 months	93.1%	95.8%	-2.7% (-9.1 to 3.7)	0.402	NS
18 months	91.7%	94.4%	-2.7% (-9.4 to 4.0)	0.428	NS

NS = Not Significant.

3.5 Marginal Bone Loss and Implant Stability

The quantitative radiographic and stability data are summarised in Table 5. MBL at 6 months showed a non-significant trend towards greater resorption in Group A (0.41 ± 0.23 mm vs 0.31 ± 0.19 mm; p = 0.073). By 12 months, MBL was significantly greater in Group A (0.68 ± 0.31 mm vs 0.54 ± 0.27 mm; mean difference 0.14 mm, 95% CI 0.04–0.24; p = 0.007). This difference persisted at 18 months (0.84 ± 0.38 mm vs 0.69 ± 0.34 mm; p = 0.014). ISQ at the time of loading was significantly higher in Group B (72.1 ± 5.8 vs 67.4 ± 6.2; p < 0.001).

Table 5: Marginal Bone Level Changes and Implant Stability Quotient

Parameter	Group A Immediate (Mean ± SD)	Group B Delayed (Mean ± SD)	Mean Diff. (95% CI)	p-value
MBL change at 6 months (mm)	0.41 ± 0.23	0.31 ± 0.19	0.10 (−0.01 to 0.21)	0.073
MBL change at 12 months (mm)	0.68 ± 0.31	0.54 ± 0.27	0.14 (0.04 to 0.24)	0.007*
MBL change at 18 months (mm)	0.84 ± 0.38	0.69 ± 0.34	0.15 (0.03 to 0.27)	0.014*
Probing Depth at 18 months (mm)	2.81 ± 0.62	2.64 ± 0.58	0.17 (−0.02 to 0.36)	0.082
Implant Stability Quotient at loading	67.4 ± 6.2	72.1 ± 5.8	−4.7 (−6.7 to −2.7)	<0.001*

**p < 0.05; MBL = Marginal Bone Loss; ISQ = Implant Stability Quotient; SD = Standard Deviation.*

3.6 Figure Legends

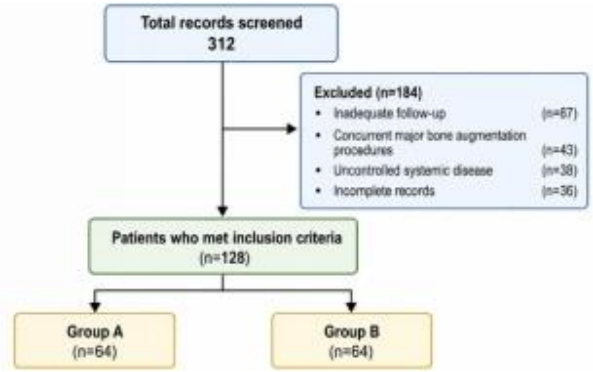

Figure 1: STROBE-compliant flowchart illustrating patient selection and group allocation. Of 312 records initially screened, 128 patients met inclusion criteria (64 per group). Major reasons for exclusion included inadequate follow-up (n = 67), concurrent major bone augmentation procedures (n = 43), uncontrolled systemic disease (n = 38), and incomplete records (n = 36).

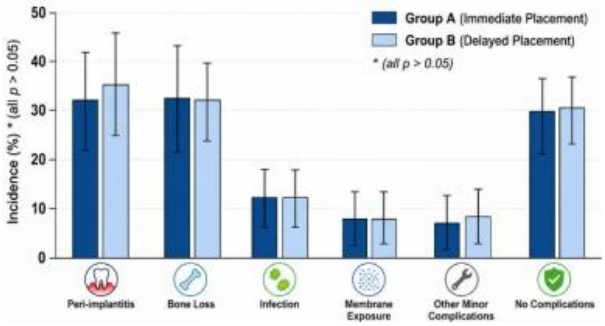

Figure 2: Grouped bar graph depicting the incidence (%) of each post-operative complication category in Group A (Immediate Placement, dark grey bars) and Group B (Delayed Placement, light grey bars). Error bars represent 95% confidence intervals. No complication reached statistical significance (all p > 0.05).

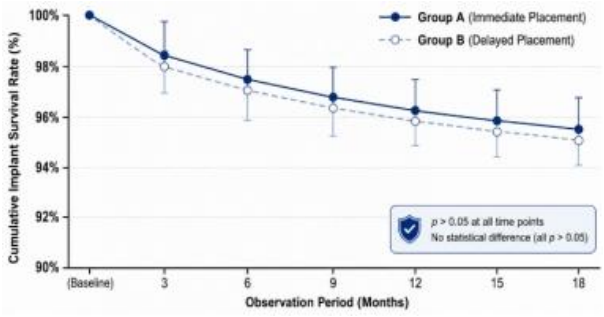

Figure 3: Line graph depicting cumulative implant survival rates (%) for Group A (immediate, solid line) and Group B (delayed, dashed line) over the 18-month observation period. The two survival curves run in close proximity throughout, consistent with the non-significant p-values at all time points.

4. DISCUSSION

A retrospective study of 128 patients with 144 implants was performed to investigate the incidence of post-operative complications and implant survival between immediate and delayed implant placement protocols in these patients, with a minimum follow-up of 18 months. The principal finding was that, although complication rates were numerically higher in the immediate placement group, no statistically significant difference was detected for any of the individual or overall complication rates at any of the evaluation periods or for implant survival. The results of this study are generally in line with the literature, except for marginal bone loss and implant stability quotient at loading, which showed significant differences favouring the delayed group.

The overall implant survival rates of 91.7% and 94.4% for immediate and delayed groups respectively, is consistent with the published literature. This is broadly in keeping with the numerical trends reported here, with a mean failure rate of 2.9% of immediate implants compared to 0% at 3 years for delayed implants in the anterior maxilla reported by Tonetti et al. in the landmark randomized controlled trial comparing immediate to delayed implants.[10] Although the placement complication rate was higher (33.3%) in the immediate placement group, it was not statistically significant (p = 0.202) compared with the delayed placement group (23.6%). This result is similar to that of the

meta-analysis conducted by Esposito and his colleagues,11 in which they found no significant difference in the failure or complication rates of Type 1 and Type 4 placement protocols among all the studies that were examined. Likewise, Gallucci et al. conducted a systematic review of placement and loading protocols, and concluded that the success rate of implants was similar between immediate and delayed placement for various types of patients when appropriate patient selection criteria were adhered to.[14]

Berglundh et al. (2018) EFP/AAP classification consensus report noted that the oral hygiene regimen in the study protocol is likely to have a beneficial effect on the incidence of peri-implant mucositis, which is a common biologic peri-implant complication in medium-term studies, with the 18-month rates observed in the present study being substantially lower, and that peri- implant mucositis is reversible with proper intervention, with all cases in this cohort resolving within two recall visits after professional debridement and reinforcement of oral hygiene.

The finding of significantly greater marginal bone loss in Group A at 12 months (0.68 ± 0.31 mm vs 0.54 ± 0.27 mm, p =0.007) and 18 months (0.84 ± 0.38 mm vs 0.69 ± 0.34 mm, p = 0.014) merits careful consideration. Both the presence or absence of a gap-filling biomaterial and the absolute differences are small and remain within clinically acceptable limits (< 1 mm at 18 months for both groups); however, the statistically significant differences at later time points may be associated with the continued remodelling of the bundle bone that lines the socket walls irrespective of the presence or absence of the biomaterial.[4,8,18]

Biologically intuitive are the significantly higher ISQ values at loading in Group B (72.1 ± 5.8) compared to Group A (67.4 ± 6.2), p < 0.001. In the present study, the implants in both groups had ISQ values greater than 60 at loading, which might be an explanation for the absence of a statistically significant difference in implant failure rate between the groups despite the difference in ISQ.

The overall infection rate of 12.5% in Group A compared with 6.9% in Group B (p = 0.254) is consistent with the existing literature on the biological risks inherent in placing implants in the inflammatory microenvironment of a fresh extraction socket.[26,45]

Paolantonio and colleagues reported a 6.3% early infection rate for immediately placed implants in a prospective study, and attributed this to the residual bacterial contamination of the socket apex and periodontal ligament fragments.[45] Van Dooren and colleagues have emphasised that buccal plate thickness is a critical modifier of infection risk in immediate placement, noting that sockets with a thin buccal plate (< 1 mm) carry a substantially elevated risk of dehiscence and subsequent infection.[29] In the present cohort, CBCT-confirmed adequate buccal plate thickness was an inclusion criterion, which likely attenuated the infection rate in Group A relative to unselected immediate placement series. There were no significant differences between the two groups with regard to soft tissue dehiscence (9.7% vs. 4.2%). A dehiscence rate of 5.5% in the immediate group is in line with the higher technical sensitivity of this placement technique.[15,22] Cosyn et al. in their 3-year case series of immediate anterior maxillary implants reported that the factors that had the greatest impact on implant exposure and contamination were tissue biotype, flap tension, and thickness of buccal bone.[15] Den Hartog et al. in their systematic review also found that the most favourable condition for achieving soft tissue stability was immediate implant placement in thick biotype patients.[22]

Overall, 6.9% of Group A implants failed and required explantation compared to 2.8% of Group B implants (p = 0.256). This difference is not statistically significant but clinically significant. In the present study failed implants were found in both smoking and non-smoking sub-groups of Group A, indicating that socket-specific factors may be as important as systemic factors in early implant failure. In a systematic

review of 23 longitudinal studies with a minimum of 10 years follow-up, Moraschini et al. reported overall implant survival rates of 94.6% but also found that early failures (those that occur within the first year) were disproportionately associated with immediate placement in posterior sites, systemic conditions, and smoking.[16]

By 4-6 months as implants were placed in Group B, the socket was filled with woven bone which is a mechanically competent implant bed and is progressing to maturation into lamellar bone.[43,44] The vascularity from this new bone formation coupled with the inflammatory resolution, is arguably a more favorable environment for early osseointegration than a socket which is also traumatised by the extraction, osteotomy preparation, and biomaterial placement.[48]

The present study findings should be considered for individual patient selection. In addition, Schimmel and co-worker noted that patient age and systemic disease burden should also be considered when making implant decisions, with ASA Class II patients showing similar implant survival when using suitable surgical protocols, compared to ASA Class I.[32]

There were some methodological limitations in the present study due to its retrospective design. First, the decision of when to place the new implant was based on clinical judgement of the surgeon rather than being random, which can lead to patient selection bias. Because of possible selection of ideal socket, the difference in complications was minimized. Third, the follow-up period of 18 months was sufficient to evaluate early complications, but not long- term biological complications such as peri-implantitis, which usually occurs after 5 years or more.[38] Third, the study was performed at a single implant centre and the generalisations of results to other implant centres should be interpreted with caution. Fourth, the diversity of the implant brands (minimised by limiting to SLA implants) can affect the osseointegration kinetics which is a possible confounding variability. Fifth, there was no systematic evaluation of patient- reported outcomes including aspects related to the quality of life, aesthetic satisfaction, or experience of pain.

To overcome these limitations, future studies should employ prospective multicentre RCTs with stratified randomisation by tooth location, wall integrity of the sockets and systemic disease with prospective patient-reported outcome measures and a long-term observation period of five years or more to measure the occurrence of peri-implantitis and the changes in marginal bone levels over time.

5. CONCLUSION

The results of the present retrospective comparative study showed that the immediate and delayed implant placement in fresh extraction sockets had comparable survival rates, post-operative complication profiles and achieved clinically acceptable results at 18 months. There was no significant difference in the overall complication rate, infection rate, peri-implant mucositis, implant failure or soft tissue dehiscence. There were statistically significant benefits in terms of bone preservation around the implant at 12 and 18 months and implant stability quotient at loading for delayed placement. These results indicate that IP might be a safe and effective treatment option in well-selected patients, that permits a shorter overall treatment duration, but that delayed IP treatment may result in slightly more predictable biological success, especially when considering the quality of osseointegration and the preservation of the crestal bone level. The placement timing is dependent on a careful case-by-case evaluation of the socket anatomy, integrity of the buccal plate, soft tissue biotype, and overall health status of the patient and their expectations. In order to get high level, definitive evidence in this area, prospective randomised controlled multicentre trials with longer follow-up and standardised outcome measures are needed.

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