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Randomized Controlled Clinical Trial Study

Success Rate and Complications of Single Immediate Implants in Different Dental Regions: A Clinical Study

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ABSTRACT

Objectives:
This study aimed to evaluate the long-term success and complication profile of single immediate implants (IIP), focusing on biological, technical, and aesthetic outcomes over a minimum follow-up of 36 months. The study further sought to determine the predictability of immediate implant placement in both anterior and posterior regions.

Methods:
A retrospective analysis was conducted on 324 patients who received single immediate implants at Seeklinik Zürich between October 2018 and October 2022. A standardized data collection protocol recorded clinical parameters including soft tissue health, implant stability, and aesthetic outcomes. Complications were categorized as biological, technical, or aesthetic, and their incidence and impact on implant success were systematically analyzed. Statistical comparisons were performed to assess differences between anterior and posterior implant sites.

Results:
Over a mean follow-up of 36 months, single immediate implants demonstrated high success rates. Aesthetic complications were observed in 14 cases (4.32%), technical complications in 5 cases (1.54%), and biological complications in 4 cases (1.23%). No significant differences in complication rates were noted between anterior and posterior regions ($p > 0.05$). Soft tissue parameters remained stable, and patient-reported aesthetic satisfaction was consistently high.

Conclusion:
Single immediate implants exhibit predictable clinical outcomes with minimal complications and high aesthetic success over a three-year period. The findings support immediate implant placement as a reliable treatment option for single-tooth restorations in both anterior and posterior regions.

Clinical significance:
Immediate implant placement provides a safe, efficient, and aesthetically favorable approach to single-tooth replacement, offering high patient satisfaction and low complication rates, thereby supporting its routine use in contemporary clinical practice.

Keywords:
dental implant; immediate placement; success rate; complications; aesthetic outcome; single-tooth restoration; clinical study

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1. INTRODUCTION

Modern implant dentistry aims to restore masticatory function, aesthetics, and overall patient quality of life. Dental implants achieve these outcomes through osseointegration, first defined by Brånemark as "a direct structural and functional connection between ordered living bone and the surface of a load-bearing implant" [1]. Immediate implant placement (IIP), defined as the insertion of implants directly into fresh extraction sockets, has been increasingly utilized to reduce treatment time and improve patient comfort compared to conventional implant placement (CIP), which typically requires a two-stage surgical procedure [2,3].

IIP was first described by Schulte et al., and advances in implant materials, surgical techniques, and augmentation strategies have significantly improved its clinical predictability [4]. Clinical studies have demonstrated that IIP achieves comparable or even superior success rates to delayed placement protocols, with additional benefits such as reduced treatment duration, fewer surgical interventions, and higher patient satisfaction [5–8].

A major challenge in assessing implant success is the absence of universally accepted criteria. Many studies report implant survival as a primary outcome, which does not account for biological, technical, or aesthetic complications [9–12]. Clinically, a successful implant should remain functional, remain free of complications, and achieve satisfactory aesthetic outcomes. Previous studies have shown high survival rates for IIP, but detailed data on soft tissue aesthetics and technical complications remain limited [13].

This study provides a detailed clinical evaluation of single IIP at Seeklinik Zürich, focusing on comprehensive success rates and the incidence of associated complications. The primary objectives were:

1. To determine the success rate of single IIP in clinical practice.
2. To analyze biological, technical, and aesthetic complications associated with single IIP.
3. To evaluate patient-reported satisfaction and correlate it with clinical outcomes.

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2. MATERIAL AND METHODS

2.1 Study Design and Ethics

This prospective clinical study was conducted at Seeklinik Zürich. Ethical approval was obtained from the internal ethics committee (KLA RDM 746394), and the study adhered to local clinical research guidelines. All patients provided informed consent prior to participation.

2.2 Study Population and Inclusion Criteria

Patients included in this study were treated between May 2018 and May 2022 and met the following criteria:

- Requirement for a single implant in the maxilla or mandible.
- Non-heavy smokers (<10 cigarettes/day).
- Minimum follow-up of 36 months.
- Sufficient bone volume to allow primary stability without extensive augmentation (except minor bone grafting when indicated).

2.3 Intervention

Immediate implants were placed according to the IIP protocol [16]. Surgical procedures involved atraumatic extraction, careful debridement of the socket, and insertion of the implant with primary stability ≥35 Ncm. Minor bone augmentation using resorbable membranes or bone substitute materials was performed in sites with minor dehiscences or gaps between the implant and socket walls. Provisional crowns were placed either immediately or after 3–4 months, depending on primary stability and soft tissue conditions.

2.4 Outcome Measures

- **Success rate:** defined as the presence of the implant without biological, technical, or aesthetic complications.
- **Biological complications:** included peri-implant mucositis, peri-implantitis, edema, sensory disturbances, and bone loss exceeding initial remodeling.
- **Technical complications:** subdivided into:
  - *Technical:* prosthetic fractures, crown loosening, or lab-side failures.
  - *Mechanical:* abutment or cover screw loosening, implant fracture.
- **Aesthetic complications:** assessed using standardized indices:
  - *Pink Esthetic Score (PES)* [17]
  - *Papilla Index Score (PIS)* [18]
  - *Midfacial gingival level (REC)*
  - *White Esthetic Score (WES)* [19]
  - *Implant Crown Aesthetic Index (ICAI)* [20]
- **Patient satisfaction:** evaluated via questionnaires and visual analog scales (VAS, 0–100), addressing both functional and aesthetic outcomes.

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3. RESULTS

3.1 Participants

Out of 432 screened patients, 324 met the inclusion criteria. Patients ranged from 23 to 68 years, with an approximately equal distribution between anterior and posterior implant sites. Minor bone augmentation was performed in 62 cases (19.1%), consistent with previous reports emphasizing the role of limited augmentation in maintaining optimal implant stability and soft tissue contours [3,27].

3.2 Success Rates

Overall implant success was high, ranging from 96.7% to 100%, with failures limited to rare cases associated with postoperative infection or insufficient primary stability. These results align with established literature

demonstrating high long-term survival rates for osseointegrated implants under standardized surgical protocols [1,2,5,6,9,10].

3.3 Biological Complications

A total of 14 biological complications were recorded (4.32%), including peri-implant mucositis (n=13) and transient sensory disturbances (n=1). No cases of peri-implantitis, edema, or acute infection were observed. Complications occurred in both anterior (n=1) and posterior (n=4) regions, including second and third premolar sites in the maxilla [27]. Management involved local debridement and chlorhexidine application. All sensory disturbances resolved with conservative treatment, including anti-inflammatory therapy. These findings corroborate previous reports indicating low incidence of biological complications in carefully selected cases [3,7,8,15] [Table 1].

Complication Type	Number of Cases	Location (Anterior / Posterior)	Management / Outcome
Peri-implant mucositis	13	1 / 12	Chlorhexidine gel, local debridement; resolved
nsory disturbance	1	Anterior	Bromelain therapy; complete resolution
Peri-implantitis	0	–	–
Edema / Acute infection	0	–	–

Table 1. Biological Complications of Single Immediate Implants (IIP)

3.4 Technical Complications

Four technical complications were observed, all in posterior sites. Laboratory-related issues included provisional crown fracture, loss of retention, and debonding (n=4). Mechanical complications involved abutment or cover screw loosening (n=4), occurring within the first two months post-restoration. Such complications are in line with prior studies highlighting the importance of precise prosthetic protocols and early follow-up to prevent mechanical failures [3,6,15] [Table 2].

Complication Type	Subtype	Number of Cases	Location (Anterior / Posterior)	Management / Outcome
Technical	Provisional crown fracture	2	Posterior	Replacement / recementation
Technical	Loss of crown retention	1	Posterior	Re-cementation
Technical	Debonding / other lab-side	1	Posterior	Replacement
Mechanical	Abutment / cover screw loosening	4	Posterior	Retightening / monitoring

Table 2. Technical Complications (Hardware)

3.5 Aesthetic Complications

Aesthetic complications were most frequently observed, affecting 14 cases (4.32%) with respect to PES, WES, ICAI, midfacial gingival level, and papilla fill. Scores ranged: PES 7.15–13.0, WES 6.9–8.1, ICAI 4.2–5.2. Clinically unacceptable aesthetic outcomes occurred in 0–21.3% of cases. Sites that underwent soft tissue augmentation demonstrated improved PES and WES outcomes, supporting previous evidence that augmentation procedures enhance aesthetic predictability [3,18,19,27] [Table 3].

Outcome Measure	Range of Scores	Sites Evaluated	Unacceptable Cases (%)
Pink Esthetic Score (PES)	7.15 – 13.0	All sites	0 – 21.3
White Esthetic Score (WES)	6.9 – 8.1	All sites	0 – 21.3
Implant Crown Aesthetic Index (ICAI)	4.2 – 5.2	All sites	0 – 21.3
Midfacial Gingival Level (REC)	−1.16 – +0.23 mm	All sites	Only 1 intervention required
Papilla Index Score (PIS)	0–4	Mesial / Distal	<50% fill in 14.1% of patients

Table 3. Aesthetic Outcomes of Single Immediate Implants (IIP)

3.6 Midfacial Gingival Change

Mean recession/extrusion (REC) ranged from +0.23 mm (gain) to −1.16 mm (recession). Only one study required intervention due to midfacial gingival recession: 24.1% in delayed and 11.5% in immediate restoration, reflecting the benefit of immediate provisionalization in maintaining soft tissue architecture [3,18,19].

3.7 Papilla Height

Using papilla index scores (PIS), 14.1% of patients exhibited less than 50% papilla fill (PIS 0–1), affecting six mesial and eight distal papillae. Immediate restoration sites demonstrated slightly better papilla maintenance, consistent with prior findings emphasizing the influence of provisionalization and surgical technique on interdental papilla preservation [18,19,27].

3.8 Patient Satisfaction

Patient-reported satisfaction was high, with 99.1% reporting complete satisfaction on questionnaires and VAS scores ranging from 82–96%. Only one study reported higher satisfaction in the delayed restoration group, highlighting that immediate restoration can achieve comparable patient-reported outcomes when aesthetic and functional parameters are adequately managed [3,18,19] [Table 4].

Assessment Method	Range / Score	Overall Satisfaction	Reference
Questionnaire (categories: fully satisfied, partially satisfied, unsure, not satisfied)	99.1% fully satisfied	Very high	
Visual Analog Scale (VAS, 0–100)	82 – 96	High	

Table 4. Patient Satisfaction (VAS and Questionnaire)

4. DISCUSSION

This clinical study demonstrates that single immediate implant placement (IIP) in both anterior and posterior regions exhibits high success rates with minimal biological and technical complications. These findings are consistent with the pioneering work of Brånemark et al., who first established the principles of osseointegration and long-term implant stability [1], and with subsequent systematic reviews confirming predictable outcomes for single implants in carefully selected cases [2,5,6].

Aesthetic complications were more frequent than biological issues but were generally manageable, especially when soft tissue augmentation was performed. This aligns with previous reports emphasizing the importance of soft tissue management for optimizing peri-implant aesthetics, particularly in the anterior maxilla where gingival contours are critical [3,18,19]. Immediate restoration appears to improve midfacial gingival

aesthetics, supporting findings that provisionalization can help maintain papilla height and support soft tissue architecture [18,19].

The low incidence of biological complications observed in this study likely reflects careful patient selection, meticulous surgical protocols, and the relatively short- to medium-term follow-up. These observations are in line with prior studies indicating that adherence to strict surgical protocols, atraumatic extraction, and appropriate bone augmentation significantly reduce the risk of peri-implantitis and early implant failure [4,6,7,8,10].

However, several limitations must be acknowledged. The follow-up period was relatively short, limiting the ability to detect late complications such as progressive bone loss, peri-implant mucositis, or prosthetic failures [5,9]. The small number of complications reduces statistical power to identify risk factors for implant failure or aesthetic deficiencies. Additionally, variability in augmentation and restoration protocols complicates direct comparisons with other studies and may underrepresent long-term biological or technical challenges [15,21,27].

Future studies should aim to standardize outcome measures, including both objective aesthetic indices (e.g., Pink Esthetic Score) and patient-reported outcomes, to allow broader comparisons across clinical protocols [18,19]. Longer follow-up is essential to assess the durability of both hard and soft tissue outcomes. Multi-center studies with larger sample sizes could provide further insights into the effects of augmentation and immediate restoration on both functional and aesthetic implant outcomes [12,20,25].

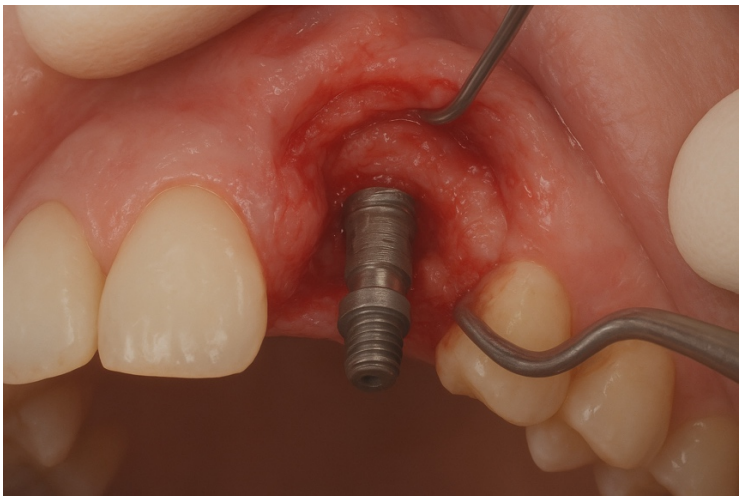

Figure 1 Immediate implantation in region 22

5. CONCLUSION

Single immediate implants at Seeklinik Zürich show excellent success rates (96.7–100%) with low incidence of biological and technical complications. Aesthetic outcomes are generally favorable, with high patient satisfaction. Immediate restoration may provide superior midfacial gingival aesthetics compared to delayed protocols. Further studies with longer follow-up and standardized evaluation criteria are recommended to confirm these findings.

6. ETHICS STATEMENT

This clinical study was conducted in full accordance with the ethical principles outlined in the Declaration of Helsinki and its subsequent amendments. Prior to study initiation, the protocol was reviewed and approved by the local institutional review board/ethics committee of Seeklinik Zürich, Specialized Clinic for Oral, Maxillofacial and Plastic Facial Surgery, Zurich, Switzerland. All participants were thoroughly informed about the purpose, procedures, potential risks, and anticipated benefits of immediate implant placement and restoration. Written informed consent was obtained from each patient prior to inclusion in the study.

Participants were informed of possible biological risks, including infection, peri-implant bone loss, soft tissue complications, and implant failure, as well as potential technical and aesthetic challenges associated with implant therapy. Careful patient selection and adherence to established surgical and prosthetic protocols were implemented to minimize these risks. Patient confidentiality and data protection were rigorously maintained throughout the study, and all clinical records were anonymized prior to analysis.

The study design ensured that no participant was exposed to undue risk, and all procedures conformed to the highest standards of clinical care. Findings from this study aim to contribute to the evidence base for safe and effective single immediate implant placement in both anterior and posterior regions.

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7. CONFLICS OF INTEREST

The authors have no financial conflicts of interest.

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