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Original Article

Classification of immediate implant placement (IIP) and immediate implant placement with provisionalization (IIPP) based on the scores of surgical and restorative difficulties

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Case selection

Abstract *Background/purpose:* Immediate implant placement (IIP) and immediate implant placement with provisionalization (IIPP) have gained popularity for reducing treatment time and improving patient outcomes. However, these techniques involve varying levels of surgical and prosthetic complexity. Existing implant classification systems primarily focus on timing and bone healing stages, but they do not fully address the combined surgical and restorative challenges presented by IIP and IIPP cases. The purpose of this article was to provide a classification system for IIP and IIPP based on their surgical and restorative difficulties.
Materials and methods: This retrospective clinical study evaluated immediate implant placement (IIP) and immediate implant placement with provisionalization (IIPP) cases performed between January 2009 and February 2024. All patients provided informed consent for their treatment data to be used for research purposes.
Results: The results of this retrospective study validate the classification system's ability to predict treatment complexity and outcomes. Cases classified as high difficulty in both surgical and restorative parameters showed lower survival rates (91.2 %), higher complication rates (35.3 %), and lower patient satisfaction scores compared to low and moderate difficulty cases.
Conclusion: The classification system proposed in this article, based on surgical and restorative

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difficulty, provides a structured approach to case selection, allowing clinicians to manage risks effectively and improve treatment outcomes. This classification system serves as a valuable tool for clinical decision-making, treatment planning, and managing patient expectations in immediate implant placement and provisionalization procedures.

Introduction

Dental implant therapy has revolutionized modern dentistry by providing predictable and long-term solutions for tooth replacement. Among various implant placement protocols, immediate implant placement (IIP) emerging as a widely accepted approach that offers reduced treatment time and improved patient satisfaction. Immediate implant placement (IIP), where an implant is placed immediately after tooth extraction—has gained widespread acceptance due to its advantages, including reduced treatment time, preservation of alveolar bone, and maintenance of soft tissue contours.[1,2] An advanced approach, immediate implant placement with provisionalization (IIPP), further enhances esthetic and functional outcomes by placing a provisional restoration at the time of implant placement, which helps in maintaining gingival architecture and patient satisfaction during the healing phase.[3–5] Despite the clinical advantages, IIP and IIPP present varying degrees of surgical and restorative complexity, influenced by factors such as alveolar bone integrity, soft tissue biotype, implant stability, and prosthetic considerations. However, not all cases are suitable for IIP or IIPP due to varying levels of surgical and restorative challenges.[6,7]

However, both procedures involve varying degrees of surgical and restorative complexity, influenced by bone quality, implant stability, soft tissue biotype, occlusion, and esthetic demands.[6–9] Improper case selection can lead to complications such as implant failure or compromised esthetics.[10]

Existing classifications focus mainly on implant timing or bone healing but overlook combined procedural challenges.[11–13] Therefore, this study proposes a classification system that separately evaluates surgical and restorative difficulty, each categorized into low, moderate, and high levels.[14–16] This approach aims to guide clinicians in risk assessment, case selection, and treatment planning to improve predictability and patient outcomes.

Materials and methods

Study design

This retrospective clinical study evaluated IIP and IIPP cases performed between January 2009 and February 2024. All patients provided informed consent for their treatment data to be used for research purposes. This study was approved by the Institutional Review Board of Kaohsiung Medical University Hospital (KMUHIRB-E(I)-20250146).

Patient selection

A total of 44 patients (23 females, 21 males) aged 32—81 years (mean age: 56.3 ± 11.8 years) who underwent IIP or IIPP procedures were included in the study. Inclusion criteria were: (1) patients requiring extraction and implant replacement of a single tooth, (2) availability of complete clinical and radiographic records, and (3) a minimum follow-up period of 12 months. Exclusion criteria were: (1) severe uncontrolled systemic diseases, (2) active periodontal disease, (3) heavy smoking (>10 cigarettes/day), and (4) pregnancy.[17,18]

Clinical and radiographic assessment

Preoperative assessment included comprehensive clinical examination and cone-beam computed tomography (CBCT) scans. The following parameters were evaluated:[16,19]

Surgical parameters

Surgical complexity was assessed based on four key parameters relevant to IIP and IIPP, each evaluated using standardized clinical and radiographic criteria.

Bone volume was assessed in three dimensions—buccolingual, mesiodistal, and apicocoronal—using cone-beam computed tomography (CBCT). Measurements were recorded in millimeters to determine the adequacy of bone to achieve primary implant stability.[20]

Socket anatomy was classified according to the system proposed by Elian et al., which categorizes extraction sockets into three types: Type I (intact buccal bone and soft tissue), Type II (intact soft tissue with partial buccal bone loss), and Type III (loss of both buccal bone and soft tissue).[21]

Soft tissue condition was evaluated based on tissue biotype (thin, medium, or thick), width of keratinized gingiva, and the presence of local inflammation or infection. These factors were considered critical in predicting soft tissue healing and the potential need for grafting.[14]

Anatomical challenges were determined by measuring the proximity of the planned implant site to vital structures, such as the maxillary sinus, nasal floor, mental foramen, or inferior alveolar nerve. Distances were obtained from CBCT scans and expressed in millimeters.[22]

Restorative parameters

Restorative complexity was evaluated using four key parameters relevant to IIP and IIPP. Each parameter was assessed through standardized clinical and patient-based criteria.

Occlusal loading was assessed through clinical examination, with specific attention to the presence of occlusal wear facets, signs of bruxism, and patient-reported parafunctional habits.[23]

Aesthetic demands were determined by evaluating the patient's smile line, visibility of the restoration during function, and the level of aesthetic expectation expressed by the patient.[24]

Patient factors included assessment of oral hygiene status using the plaque index, self-reported smoking behavior, and the presence of systemic conditions known to influence implant prognosis, such as diabetes mellitus.[25]

Provisionalization complexity was determined by the prosthetic requirements necessary to support soft tissue contours. Parameters included the design of the provisional restoration, the need for papilla support, and the development of a natural-looking emergence profile.[26]

Surgical and restorative procedures

All procedures were performed under local anesthesia in accordance with standardized clinical protocols.[27] Atraumatic tooth extractions were carried out using periotomes and luxators, followed by meticulous socket debridement and saline irrigation.[28] Implant sites were prepared according to the manufacturer's guidelines, ensuring primary stability with insertion torque ≥35 N/cm. When indicated, guided bone regeneration was performed using a 50/50 cortical-cancellous allograft and resorbable collagen membrane.[29] Soft tissue management-such as connective tissue or double papilla grafts-was applied based on clinical need.[30] For immediate provisionalization, prefabricated or custom-milled PMMA restorations were used.[31]

Scoring system development

A scoring system (1–3) was developed to classify case difficulty based on clinical experience and literature.[32]

Surgical difficulty scores (Table 1)

Surgical difficulty was scored (1–3) across four parameters: bone volume, socket anatomy, soft tissue, and anatomy, yielding a total score of 4–12.

Bone volume was scored via CBCT: 1 for >2 mm apical bone with intact buccal plate, 2 for 1–2 mm or minor dehiscence, and 3 for <1 mm or major buccal defect.[33]

Socket anatomy was scored per Elian et al.: Type I = 1, Type II (buccal bone loss) = 2, and Type III (bone and soft tissue loss) = 3.[21]

Soft tissue condition was scored by tissue biotype, keratinized mucosa width, and inflammation: thick biotype with >2 mm of keratinized tissue = 1, medium biotype with 1–2 mm = 2, and thin biotype with <1 mm or any sign of inflammation or infection = 3.[14]

Anatomical challenges were determined by measuring the proximity of the implant site to vital anatomical structures (e.g., maxillary sinus, nasal floor, mental foramen, inferior alveolar nerve) on CBCT. A score of 1 was assigned for distances >5 mm, 2 for 2–5 mm, and 3 for <2 mm.[22]

Restorative difficulty scores: (Table 2)

Restorative complexity was scored (1–3) across four parameters: occlusal loading, aesthetic demands, patient-related factors, and provisionalization, totaling 4–12.

Occlusal loading was scored: 1 for normal forces/no parafunction, 2 for moderate forces or minor habits, 3 for heavy forces or bruxism.[23] Aesthetic demands were scored: 1 for low smile lines/non-esthetic zones, 2 for moderate visibility, and 3 for high smile lines or esthetic-critical areas.[24] Patient factors were scored based on oral hygiene, smoking, and systemic health. Score 1: excellent hygiene, non-smoker. Score 2: moderate hygiene or light smoker. Score 3: poor hygiene or heavy smoker.[25] Provisionalization was scored by complexity: 1 for minimal contouring, 2 for moderate soft tissue shaping, and 3 for extensive contouring to support papillae or sculpt tissues.[26]

Surgical difficulty classification

Surgical difficulty was categorized as low, moderate, or high based on bone volume, socket anatomy, soft tissue, and anatomical risks, using clinical and radiographic criteria with case examples.

Low surgical difficulty involved adequate bone for stability, minimal defects, intact buccal plate, healthy keratinized tissue, and no anatomical risks-e.g., a straightforward

Table 1 Surgical difficulty scores.

Category	Score 1 (Low difficulty)	Score 2 (Medium difficulty)	Score 3 (High difficulty)
Bone volume[33]	>2 mm of bone beyond apex and intact buccal plate	1–2 mm of bone beyond apex or minor buccal dehiscence	<1 mm of bone beyond apex or major buccal dehiscence
Socket anatomy[21]	Type I socket (intact)	Type II socket (buccal bone deficiency)	Type III socket (buccal bone and soft tissue deficiency)
Soft tissue condition[14]	Thick biotype, >2 mm keratinized tissue	Medium biotype, 1–2 mm keratinized tissue	Thin biotype, <1 mm keratinized tissue or inflammation
Anatomical challenges[22]	>5 mm from vital structures	2–5 mm from vital structures	<2 mm from vital structures

Table 2 Restorative difficulty scores.

Category	Score 1 (Low difficulty)	Score 2 (Medium difficulty)	Score 3 (High difficulty)
Occlusal loading[23]	Normal occlusion	Moderate forces/minimal parafunctional habits	Heavy forces/significant parafunctional habits
Aesthetic demands[24]	Low smile line/non-aesthetic zone	Medium smile line/moderately visible	High smile line/highly visible
Patient factors[25]	Excellent oral hygiene/non-smoker	Moderate oral hygiene/light smoker	Poor oral hygiene/heavy smoker
Provisionalization complexity[26]	Simple emergence profile/ minimal contouring	Moderate contouring needed	Complex emergence profile/significant contouring needed

anterior maxillary extraction.[34] Moderate surgical difficulty involved minor bone loss or buccal dehiscence needing GBR, soft tissue issues, and proximity to vital structures-e.g., premolars with small defects or anatomical challenges.[35] High surgical difficulty included major bone loss needing grafting (e.g., sinus lift), severe socket defects, poor soft tissue, and proximity to vital structures—e.g., posterior maxillary molars with extensive tissue loss.[36]

Restorative difficulty classification

Restorative difficulty—low, moderate, or high—was based on occlusal load, esthetics, and patient factors, reflecting increasing prosthetic complexity with case examples.

Low restorative difficulty involved low load, minimal esthetic demands, good hygiene, and no parafunction-e.g., a single posterior mandibular implant.[37] Moderate restorative difficulty included moderate occlusal forces, visible premolars or canines, minor parafunction, or inconsistent hygiene—requiring careful planning and follow-up.[38] High restorative difficulty included heavy function (e.g., bruxism), high esthetic demands (e.g., anterior maxilla), and risk factors like poor hygiene or smoking-e.g., an anterior implant in a high-smile, thin-biotype patient.[39]

Difficulty integration criteria (Table 3)

Surgical and restorative scores were combined into nine profiles (e.g., Low—Low, High—High) to guide treatment planning, patient discussion, and outcome prediction. The integrated system combines surgical and restorative factors. Low—Low cases are simple, with good anatomy, low prosthetic demands, and predictable outcomes needing minimal intervention. Moderate combinations (e.g., Moderate—Moderate, Low—High) need detailed planning to manage minor defects, moderate loading, or esthetic concerns via grafting, provisional design, or occlusal tuning. High—High cases are the most complex, with major surgical and restorative challenges needing advanced techniques, team care, detailed consent, and staged treatment for success.

Case classification

Case complexity was scored (4—12) for surgery and restoration: 4 = low, 5—8 = moderate, 9—12 = high, allowing standardized comparisons.[32]

Results

Patient and implant distribution

Among 44 patients, 53 implants were placed using IIP or IIPP protocols: 28 maxillary anterior (52.8 %), 10 maxillary posterior (18.9 %), 8 mandibular anterior (15.1 %), and 7 mandibular posterior (13.2 %).

Case classification

Based on the classification, surgical difficulty was low in 15 cases (28.3 %), moderate in 24 (45.3 %), and high in 14 (26.4 %). Restorative difficulty was low in 12 cases (22.6 %), moderate in 27 (50.9 %), and high in 14 (26.4 %). Combined scores showed: Low—Low (8 cases, 15.1 %), Low—Moderate (5 cases, 9.4 %), Low—High (1 case, 1.9 %), Moderate-Low (3 cases, 5.7 %), Moderate—Moderate (17 cases, 32.1 %), Moderate—High (4 cases, 7.5 %), High—Low (1 case, 1.9 %), Hig—Moderate (5 cases, 9.4 %), High—High (9 cases, 17.0 %). Results showed varied case complexities, mostly moderate. The combined system offers a clear framework for assessing immediate implant cases.

Clinical outcomes based on difficulty classification

Implant survival

At the final follow-up, the overall implant survival rate was 96.2 % (51 out of 53 implants). When analyzed according to the combined surgical and restorative difficulty classification, survival rates varied across different case complexities. A 100 % survival rate was observed in the following subgroups: low surgical/low restorative difficulty (8/8), low surgical/moderate restorative difficulty (5/5), low surgical/high restorative difficulty (1/1), moderate surgical/low restorative difficulty (4/4), moderate surgical/moderate restorative difficulty (17/17), moderate surgical/high restorative difficulty (4/4), and high surgical/low restorative difficulty (1/1).

Slightly lower survival was seen in high-complexity groups: 87.5 % in High—Moderate (7/8) and 80.0 % in High—High (4/5), with a significant difference across groups ($P = 0.045$).[40] Findings indicate high overall survival for immediate implants, but combined high surgical and restorative complexity may increase failure risk.

Table 3 Integrated surgical and restorative difficulty classification.

Difficulty level	Surgical criteria	Restorative criteria	Clinical examples
Low–low	Adequate bone volume, intact socket, thick soft tissue, no anatomical risks	Minimal occlusal load, non-esthetic zone, excellent hygiene, no parafunction	Posterior molar replacement in healthy patients with good tissue support
Low–moderate	Favorable bone and socket anatomy, minimal soft tissue concern	Moderate occlusal or esthetic demands, minor hygiene concerns or habits	Premolar implant in mildly esthetic zone with minor occlusal risk
Low–high	Favorable surgical anatomy but demanding prosthetic expectations (e.g., esthetic zone)	High occlusal forces or esthetic challenges, parafunction, or thin biotype	Anterior maxillary implant in esthetic zone with high smile line, but good bone volume
Moderate–low	Moderate bone/sockets issues with manageable anatomical risks	Low esthetic/functional demand, cooperative patient	Posterior implant with mild bone defect in compliant patient
Moderate–moderate	Moderate bone defects or GBR required, mild anatomical risks, manageable soft tissue challenges	Moderate occlusion, moderate esthetic demands, and manageable patient-related factors	Premolar or canine site with mild bone loss and moderate visibility
Moderate–high	GBR required, moderate anatomical risks, soft tissue grafting required	Complex esthetics or functional demand, parafunction present, thin tissue	High-demand anterior case with moderate surgical complexity
High–low	Severe bone loss or proximity to vital structures, requiring advanced surgery	Low functional/aesthetic demand, compliant patient	Posterior molar with sinus lift, but no esthetic or occlusal concerns
High–moderate	Complex anatomy and bone loss requiring multiple regenerative procedures	Moderate occlusal load or esthetic demand, minor parafunction	Posterior maxilla implant with GBR/sinus lift in partially visible region
High–high	Severe bone and soft tissue loss, complex socket anatomy, high surgical risk	High esthetic/functional demands, significant parafunctional habits, poor oral hygiene	Anterior maxilla with severe bone loss, thin biotype, high smile line, and bruxism

Marginal bone level changes

At final follow-up, the overall mean marginal bone loss was 0.74 ± 0.63 mm. Bone loss increased with surgical difficulty: 0.43 ± 0.31 mm in low, 0.69 ± 0.52 mm in moderate, and 1.12 ± 0.78 mm in high difficulty cases. This difference was statistically significant ($P < 0.001$). These findings indicate that greater surgical complexity may be associated with increased marginal bone remodeling, likely due to anatomical and procedural factors affecting bone stability.

Soft tissue parameters

At final follow-up, mean probing depth was 2.8 ± 0.9 mm, with bleeding on probing in 18.4 % of sites. Keratinized tissue averaged 3.7 ± 1.4 mm. Soft tissue recession occurred in 13.2 % of cases (mean 0.6 ± 0.8 mm), significantly higher in high difficulty cases (1.1 ± 1.0 mm) than in moderate (0.5 ± 0.7 mm) and low (0.2 ± 0.3 mm) groups ($P < 0.001$).[40]

Aesthetic outcomes

Mean pink and white esthetic scores were 11.3 ± 1.8 (out of 14) and 8.2 ± 1.4 (out of 10), respectively. High restorative difficulty cases had significantly lower total esthetic scores (17.8 ± 2.5) than moderate (19.7 ± 2.1) and low difficulty cases (21.1 ± 1.6) ($P < 0.001$).[41]

Complication rates

Complications occurred in 15.1 % of cases (8/53), with rates increasing alongside case complexity. No complications were seen in low surgical/low restorative cases (0/8), while moderate/moderate cases had a rate of 11.8 % (2/17), and high surgical/high restorative cases showed the highest rate at 33.3 % (3/9). Common complications included soft tissue recession (7.5 %), thread exposure (4.2 %), provisional fracture (3.8 %), mucositis (3.3 %), and implant failure (2.8 %).[40] These results highlight the link between higher procedural difficulty and complication risk, underscoring the need for thorough case selection and risk assessment.

Patient satisfaction

Mean patient satisfaction was 8.7 ± 1.3, with higher scores in low difficulty cases (9.3 ± 0.8) compared to moderate (8.8 ± 1.1) and high difficulty cases (7.9 ± 1.6) ($P < 0.001$).[40]

Correlation analysis

Regression analysis showed both surgical and restorative difficulty scores significantly predicted outcomes. Surgical difficulty correlated more with bone loss ($r = 0.68$) and soft tissue health ($r = 0.62$), while restorative difficulty

correlated more with esthetics (r = 0.71) and patient satisfaction (r = 0.59) (all $P < 0.001$).[40]

Clinical case examples

Example case 1: high-difficulty surgical and restorative case (Fig. 1). A 50-year-old male with a high smile line and a fractured Tooth 21 underwent IIP with palatal implant placement and primary stability. A Type III buccal defect was managed with GBR using a 50/50 allograft and collagen membrane, along with a double papilla graft for soft tissue enhancement.[29] Final follow-up showed 8 mm soft tissue gain and favorable esthetic and functional results. The case was classified as high difficulty, with surgical and restorative scores both totaling 10. Surgical parameters included bone volume (3), socket anatomy (3), soft tissue (3), and anatomy (1); restorative factors included occlusion (3), esthetics (3), patient (2), and provisionalization (2). At 36 months, the implant showed

Figure 1 Tooth 21. A. The clinical view before treatment. B. Fracture of tooth 21, lateral view. C. Occlusal view. D. The implant was placed in a palatal position within the extraction socket of tooth 21, and a resorbable collagen membrane was applied to the buccal aspect to facilitate guided bone regeneration and soft tissue support. E. Bone graft. F. Double papilla soft tissue graft was done to improve the recession. G. 4 months follow up, recession improved. H. Final crown. I. Periapical radiograph before treatment. J. Periapical radiograph after final crown placement. K. Preoperative gingival margin positioned 6 mm apical to the gingival line (−6 mm). L. Postoperative gingival margin shows 2 mm coronal advancement (+2 mm).

stable integration and notable soft tissue improvement despite initial challenges.

Example case 2: moderate-difficulty surgical and restorative case (Fig. 2). A 75-year-old female underwent immediate implant placement at Tooth 14 with central positioning and primary stability. GBR using a 50/50 cortical-cancellous allograft was performed, and a healing abutment was placed without soft tissue grafting. A custom abutment replicating Tooth 15's contour was used to optimize emergence profile. At 48 months, the restoration showed excellent esthetics, function, and no marginal bone loss.

The case was classified as moderate surgical difficulty, with scores assigned as follows: bone volume (2), socket anatomy (1), soft tissue condition (1), and anatomical challenges (1), for a total surgical difficulty score of 5. Restorative difficulty was also moderate, with scores of occlusal loading (2), esthetic demands (2), patient factors (1), and provisionalization complexity (1), totaling 6. The successful outcome underscores the predictability of IIP in posterior sites with favorable anatomy and manageable restorative demands.

Example case 3: long-term outcome in a moderate-difficulty case (Fig. 3). A 45-year-old female underwent IIP at Tooth 36 after separate root extraction. The implant was placed in the septal bone (Type B configuration) with primary stability. Minor GBR with particulate allograft and collagen membrane supported soft tissue healing.[34]

At the 14-year follow-up, peri-implant tissues remained stable with no inflammation or recession. This case was classified as moderate surgical difficulty, with the following parameter scores: bone volume (2), socket anatomy (2), soft tissue condition (1), and anatomical challenges (1), yielding a total surgical difficulty score of 6. Restorative complexity was also deemed moderate, based on occlusal loading (2), esthetic demands (1), patient factors (1), and provisionalization complexity (1), for a total restorative score of 5. The successful outcome highlights the long-term predictability of IIP in posterior molars with sufficient septal bone and soft tissue support.

Discussion

Effective IIP/IIPP management depends on evaluating surgical and restorative challenges. The present study demonstrated that high-difficulty cases tend to result in lower implant survival rates, higher complication rates, and lower patient satisfaction scores. Therefore, accurate case classification using the proposed scoring system can improve decision-making and reduce unfavorable outcomes.[42]

High surgical difficulty cases often involved significant bone deficiencies, compromised socket anatomy, and challenging anatomical conditions. Such scenarios required advanced techniques like GBR and soft tissue grafting to optimize implant stability and aesthetics. On the other hand, cases with high restorative difficulty often involved patients with heavy occlusal loads, poor oral hygiene, or high aesthetic expectations. The results support the notion that even when surgical challenges are minimal, complex restorative factors can compromise long-term success.

These findings align with studies by Chen, Buser, and Esposito et al., highlighting the role of bone quality and soft tissue management in implant success.[1,5] Additionally, Kan et al. also noted that high restorative demands, especially in the anterior maxilla, raise the risk of esthetic failure and dissatisfaction.[4] This study confirms the link between difficulty classification and patient-reported outcomes.

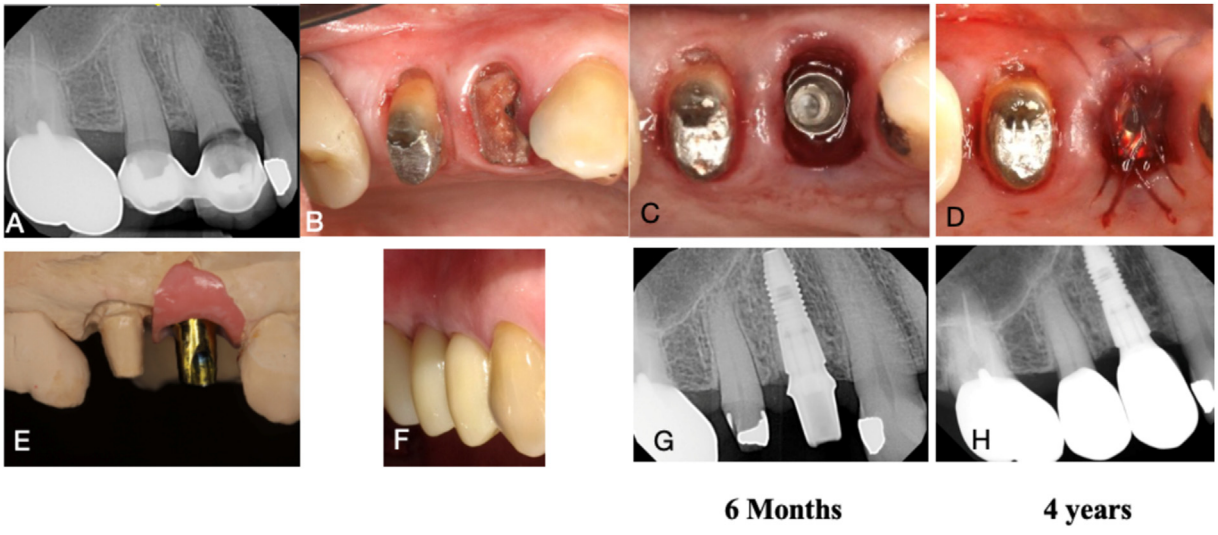

Figure 2 Tooth 14. A. Periapical radiograph before treatment. B. Fracture of tooth 14. C. Implant placement at the center of the socket of tooth 14 with primary stability. D. Bone graft, healing abutment applied and suture without soft tissue graft. E. Tooth 14 custom abutment mimics natural tooth 15. F. Final crowns with identical emergence profile between tooth 14 and tooth 15 (tooth14 implant crown and tooth 15 natural tooth crown). G. periapical radiograph shows identical abutment design of tooth 14 and tooth 15 with the follow-up of 4 years. H. Final crowns show identical emergence profile of tooth 14 and tooth 15 with the follow-up of 4 years.

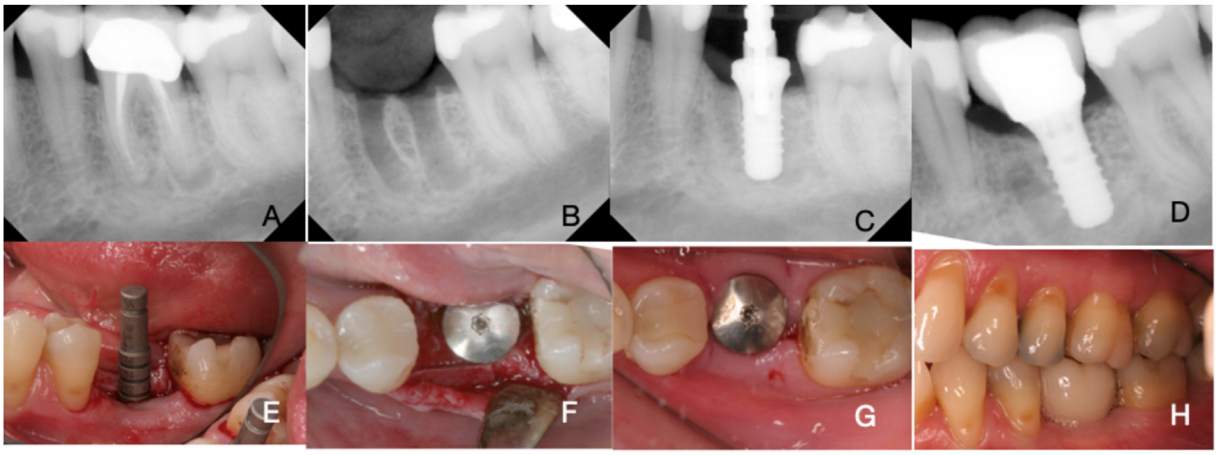

Figure 3 Tooth 36. A. Periapical radiograph before treatment. B. Periapical radiograph after extraction. C. Periapical radiograph after implant placement & GBR. D. Periapical radiograph shows final crown with identical emergence profile. E. Guide pin during implant surgery. F. Tissue level implant placement with primary stability, bone graft and collagen membrane placed. G. Post-suturing view showing well-adapted and fully supported soft tissue coverage over the grafted area. H. Definitive restoration at the 14-year follow-up, showing long-term stability of the crown and surrounding soft tissue architecture.

The proposed system offers a practical way to assess IIP/IIPP cases, helping clinicians anticipate risks, customize treatment, and guide patient expectations. Additionally, this classification can serve as a valuable educational tool for training less experienced practitioners in identifying and addressing potential challenges.

Moreover, the results align with previous recommendations from Buser et al. and Lang et al., which emphasized the importance of comprehensive case selection and risk assessment.[2,7] Utilizing a structured scoring system reduces subjective decision-making and promotes evidence-based treatment planning.

Digital tools like CBCT and CAD/CAM enhance predictability in complex cases by improving implant placement, customized provisionalization, and optimized esthetic outcomes. Virtual planning and guided surgery also reduce errors and improves overall treatment precision. Hammerle and Monje et al. showed that digital tools improve anatomical visualization and predictability in complex implant cases.[19,20]

Patient satisfaction remains a critical outcome measure. While cases classified as low or moderate difficulty demonstrated high satisfaction scores, high-difficulty cases were more likely to yield esthetic and functional dissatisfaction. Patient education and clear communication regarding the complexity and potential limitations of treatment are essential for maintaining realistic expectations and enhancing satisfaction.

This study confirms the classification system's predictive value, as high-difficulty cases showed lower survival (91.2 %), more complications (35.3 %), and reduced satisfaction compared to less complex cases.[40]

Belser et al. also reported a strong link between difficulty and esthetic outcomes, especially in the anterior maxilla.[41] Effective patient counseling and involving patients in the treatment planning process are essential for improving satisfaction levels in high-difficulty cases.

This study is retrospective in nature, which introduces inherent biases and limitations. Prospective, multicenter studies with larger sample sizes and longer follow-up periods are needed to further validate the classification system's effectiveness. Additionally, the integration of artificial intelligence algorithms to automate classification and predict outcomes could further refine decision-making in IIP and IIPP procedures.

Future research could also explore the influence of clinician experience and technical proficiency on treatment outcomes. Studies comparing outcomes between specialists and general practitioners could provide further insights into the applicability of the classification system across different practice settings.

Immediate implant placement and provisionalization offer clear benefits but vary in complexity. The proposed classification system helps clinicians assess surgical and restorative challenges, improving risk management, predictability, and treatment outcomes. By understanding the interplay between surgical and restorative challenges, clinicians can enhance predictability, minimize complications, and ensure successful, aesthetic, and functional restorations. This classification system serves as a valuable tool for clinical decision-making, treatment planning, and managing patient expectations in immediate implant placement and provisionalization procedures.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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References

1. Chen ST, Buser D. Esthetic outcomes following immediate and early implant placement in the anterior maxilla- a systematic review. *Int J Oral Maxillofac Implants* 2014;29(Suppl):186—215.
2. Lang NP, Pun L, Lau KY, Li KY, Wong MCM. A systematic review on survival and success rates of implants placed immediately into fresh extraction sockets after at least 1 year. *Clin Oral Implants Res* 2012;23(Suppl 5):39—66.
3. Kan JYK, Rungcharassaeng K, Lozada JL. Immediate implant placement and provisionalization of maxillary anterior single implants. *Comp Cont Educ Dent* 2018;39:e1—7.
4. Kan JYK, Rungcharassaeng K, Deflorian M, Weinstein T, Wang HL, Testori T. Immediate implant placement and provisionalization of maxillary anterior single implants. *Periodontol* 2000 2018;77:197—212.
5. Esposito M, Grusovin MG, Polyzos IP, Felice P, Worthington HV. Timing of implant placement after tooth extraction: immediate, immediate-delayed or delayed implants? A cochrane systematic review. *Eur J Oral Implant* 2010;3:189—205.
6. Grunder U, Gracis S, Capelli M. Influence of the 3-D bone-to-implant relationship on esthetics. *Int J Periodontics Restor Dent* 2005;25:113—9.
7. Buser D, Chappuis V, Belser UC, Chen S. Implant placement post extraction in esthetic single tooth sites: when immediate, when early, when late? *Periodontol* 2000 2017;73:84—102.
8. Esposito M, Grusovin MG, Willings M, Coulthard P, Worthington HV. The effectiveness of immediate, early, and conventional loading of dental implants: a cochrane systematic review of randomized controlled clinical trials. *Int J Oral Maxillofac Implants* 2012;24:893—904.
9. Chappuis V, Engel O, Reyes M, Shahim K, Nolte LP, Buser D. Ridge alterations post-extraction in the esthetic zone: a 3D analysis with CBCT. *J Dent Res* 2017;92(Suppl 12):195—201.
10. Slagter KW, Raghoebar GM, Vissink A, Meijer HJA. Immediate placement of single implants with or without immediate provisionalization in the maxillary aesthetic region: a 5-year comparative study. *J Clin Periodontol* 2021;48:272—83.
11. Wang HL, Shotwell J, Itose T, et al. Multidisciplinary treatment planning for dental implants: a case classification system. *J Mich Dent Assoc* 2005;87:26—31.
12. Dawson A, Chen S. *The SAC classification in implant dentistry*. Quintessence Publishing, 2009.
13. Hammerle CHF, Chen ST, Wilson TG. Consensus statements and recommended clinical procedures regarding implant placement into extraction sockets. *Int J Oral Maxillofac Implants* 2004;19(Suppl):26—8.
14. Linkevicius T, Apse P, Grybauskas S, Puisys A. The influence of soft tissue thickness on crestal bone changes around implants: a 1-year prospective controlled clinical trial. *Int J Oral Maxillofac Implants* 2009;24:712—9.
15. Palattella P, Torsello F, Cordaro L, Mirisola di Torresanto V. Influence of implant placement timing on long-term esthetic outcomes in single-tooth replacement. *Clin Implant Dent Relat Res* 2017;19:477—85.
16. Jacobs R, Salmon B, Codari M, Hassan B, Bornstein MM. Cone beam computed tomography in implant dentistry: recommendations for clinical use. *BMC Oral Health* 2018;18:88—104.
17. Chrcanovic BR, Albrektsson T, Wennerberg A. Smoking and dental implants: a systematic review and meta-analysis. *J Dent* 2015;43:487—98.
18. Marconcini S, Barone A, Gelpi F, Briguglio F, Covani U. Immediate implant placement in infected sites: a case series study after 1 year of loading. *J Periodontol* 2013;84:196—202.
19. Hämmerle CHF, Cordaro L, van Assche N, et al. Digital technologies to support planning, treatment, and fabrication processes and outcome assessments in implant dentistry. Summary and consensus statements. *Clin Oral Implants Res* 2015;26(Suppl 11):97—101.
20. Monje A, Chappuis V, Monje F, et al. The critical peri-implant buccal bone wall thickness revisited: an experimental study in the beagle dog. *Int J Oral Maxillofac Implants* 2019;34:1328—36.
21. Elian N, Cho SC, Froum S, Smith RB, Tarnow DP. A simplified socket classification and repair technique. *Pract Proced Aesthetic Dent PPAD* 2007;19:99—104.
22. Bornstein MM, Al-Nawas B, Kuchler U, Tahmaseb A. Consensus statements and recommended clinical procedures regarding contemporary surgical and radiographic techniques in implant dentistry. *Int J Oral Maxillofac Implants* 2014;29(Suppl):78—82.
23. Koyano K, Esaki D. Occlusion on oral implants: current clinical guidelines. *J Oral Rehabil* 2015;42:153—61.
24. Chu SJ, Tan JH, Stappert CF, Tarnow DP. Gingival zenith positions and levels of the maxillary anterior dentition. *J Esthetic Restor Dent* 2009;21:113—20.
25. Renvert S, Persson GR, Pirih FQ, Camargo PM. Peri-implant health, peri-implant mucositis, and peri-implantitis: case definitions and diagnostic considerations. *J Clin Periodontol* 2018;45(Suppl 20):278—85.
26. Su H, Gonzalez-Martin O, Weisgold A, Lee E. Considerations of implant abutment and crown contour: critical contour and subcritical contour. *Int J Periodontics Restor Dent* 2010;30:335—43.
27. Chen ST, Wilson Jr TG, Hämmerle CH. Immediate or early placement of implants following tooth extraction: review of biologic basis, clinical procedures, and outcomes. *Int J Oral Maxillofac Implants* 2004;19(Suppl):12—25.
28. Fickl S, Zuhr O, Wachtel H, Bolz W, Huerzeler M. Tissue alterations after tooth extraction with and without surgical trauma: a volumetric study in the beagle dog. *J Clin Periodontol* 2008;35:356—63.
29. Urban IA, Lozada JL, Jovanovic SA, Nagursky H, Nagy K. Vertical ridge augmentation with titanium-reinforced, dense-PTFE membranes and a combination of particulated autogenous bone and anorganic bovine bone-derived mineral: a prospective case series in 19 patients. *Int J Oral Maxillofac Implants* 2014;29:185—93.
30. Zuhr O, Bäumer D, Hürzeler M. The addition of soft tissue replacement grafts in plastic periodontal and implant surgery: critical elements in design and execution. *J Clin Periodontol* 2014;41(Suppl):123—42.
31. Wittneben JG, Brägger U, Buser D, Joda T. Volumetric calculation of supraimplant submergence profile after soft tissue conditioning with a provisional restoration. *Int J Periodontics Restor Dent* 2016;36:785—90.
32. Levine RA, Nack G. Team treatment planning for the replacement of esthetic zone teeth with dental implants. *Comp Cont Educ Dent* 2011;32:44—50.
33. Chappuis V, Araújo MG, Buser D. Clinical relevance of dimensional bone and soft tissue alterations post-extraction in esthetic sites. *Periodontol* 2000 2017;73:73—83.

34. Gluckman H, Salama M, Du Toit J. A retrospective evaluation of 128 socket-shield cases in the esthetic zone and posterior sites: partial extraction therapy with up to 4 years follow-up. *Clin Implant Dent Relat Res* 2018;20:122—9.
35. Schropp L, Wenzel A, Kostopoulos L, Karring T. Bone healing and soft tissue contour changes following single-tooth extraction: a clinical and radiographic 12-month prospective study. *Int J Periodontics Restor Dent* 2003;23:313—23.
36. Urban IA, Lozada JL, Nagy K, Sanz M. Treatment of severe mucogingival defects with a combination of strip gingival grafts and a xenogeneic collagen matrix: a prospective case series study. *Int J Periodontics Restor Dent* 2015;35:345—53.
37. Payne AG, Tawse-Smith A, Thomson WM, Duncan WD, Kumara R. One-stage surgery and early loading of three implants for maxillary overdentures: a 1-year report. *Clin Implant Dent Relat Res* 2004;6:61—74.
38. Cooper LF, Reside GJ, Raes F, et al. Immediate provisionalization of dental implants placed in healed alveolar ridges and extraction sockets: a 5-year prospective evaluation. *Int J Oral Maxillofac Implants* 2014;29:709—17.
39. Gallucci GO, Morton D, Weber HP. Loading protocols for dental implants in edentulous patients. *Int J Oral Maxillofac Implants* 2009;24(Suppl):132—46.
40. Lang NP, Berglundh T, Heitz-Mayfield LJ, Pjetursson BE, Salvi GE, Sanz M. Consensus statements and recommended clinical procedures regarding implant survival and complications. *Int J Oral Maxillofac Implants* 2004;19(Suppl):150—4.
41. Belser UC, Grütter L, Vailati F, Bornstein MM, Weber HP, Buser D. Outcome evaluation of early placed maxillary anterior single-tooth implants using objective esthetic criteria: a cross-sectional, retrospective study in 45 patients with a 2- to 4-year follow-up using pink and white esthetic scores. *J Periodontol* 2009;80:140—51.
42. Blatz MB, Chiche G, Bahat O, Roblee R, Coachman C, Heymann HO. Evolution of aesthetic dentistry. *J Dent Res* 2019;98:1294—304.