REVIEW ARTICLE

IMMEDIATE DENTAL IMPLANT PLACEMENT: A REVIEW

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ABSTRACT

Tooth loss as a result of extraction especially in the esthetic zone can be a challenge in its rehabilitation due to the loss of bone volume. Immediate implant placement has been well documented and studies have shown that the success of immediately placed dental implants is almost the same as delayed placement. This article aims to highlight immediate implant placement and their success in the replacement of partial or complete edentulous arches.

KEY WORDS

Immediate implant; osseointegration; primary stability

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INTRODUCTION

The successful replacements of missing teeth in man have long been attempted since the ancient Egyptians and Chinese civilization as far back as 4000 years ago. Implant dentistry, has far progressed and successful ever since Branemark described Osseointegration as the direct bone implant contact rather than fusion or ankylosis which became the governing factor for the success of dental implants. Tooth loss, whether single or multiple, can be a detrimental factor which effects the quality of life of a person. Replacement of missing teeth with dental implants is now considered the most recent advancement in the rehabilitation of missing tooth or teeth. During the past 40 years, prosthetic rehabilitation ofthe edentulous patient with implant-supported bridges has developed into a viable and predictable treatment option. High clinical success rates with the original implant protocol shave given clinicians and researchers confidence to further develop and refine the osseointegrated technique and, consequently, implants are used in increasingly more challenging situations and on broader indications. In general, the 5-year survival rate of implants is approximately 95%, and the 10-year survival rate is greater than 89%.[1] Nevertheless, over the years, researchers tried to minimize the treatment time needed and hence, timing of implant placement has become a recent interest by many researchers.

Previously, practitioners allowed a socket healing time of 12 months or longer before placing dental implants to restore an edentulous space.[2] Such a lag time brought the patient compromised comfort, function, and aesthetics. In 1978, the first report of a situation, in which the extraction followed by the placement of an implant into the fresh socket at the same appointment, was described as the "Tu¨rbingen immediate implant".[3] This method reduced the number of dental appointments, the time of treatment and the number of surgeries required.

The following new classification based on morphologic, dimensional and histologic changes that follow tooth extraction was proposed at the Third ITI Consensus Conference[4]:

Type 1: Immediate placement: an implant is placed

immediately in an extraction socket as part of the same procedure with no healing of bone or soft tissues.

Type 2: Early placement (typically 4-8 weeks of healing) with some soft tissue healing: the post-extraction site has healed soft tissue coverage of the alveolus but without significant bone healing.

Type 3: Early placement with partial bone healing (typically 12-16 weeks of healing): The post-extraction site has both healed soft tissues and a significant degree of bone healing.

Type 4: Late placement (more than 6 months after extraction): implant placement in a fully healed edentulous site.

Immediate loading is often defined in terms of timing as at the same clinical visit as implant placement. With the single-implant scenario, this is often achievable and may be advantageous in supporting soft-tissue contour. When considering partial and complete edentulism, the logistics of providing a provisional restoration often dictate a delay from the time of implant placement. For this reason as opposed to any biological basis, "immediate" is most often defined as "within 48 h." The term "immediate loading" is reserved for full occlusal loading in at least centric occlusion and "immediate restorations" or "nonocclusal loading" for restorations with no centric or eccentric contacts[5].

INDICATIONS

- Traumatically avulsed
- Residual deciduous teeth
- Horizontal/vertical fracture of teeth
- Failing endodontically treated teeth
- Non-restorable teeth.
- Patients with thick gingival tissue biotypes

CONTRAINDICATIONS

- Inability to establish mechanical stability (i.e., inadequate
- width and/or height of available bone)
- Proximity to adjacent teeth
- Placement of implant outside alveolar envelop
- Presence of infection.

DIAGNOSIS AND TREATMENT PLANNING

Proper diagnosis of the patient's condition is important to allow clinicians to formulate an optimal and predictable treatment plan. By recognizing unfavorable conditions, adjunctive procedures can be incorporated to avert compromised situations.

Table 1 Advantages and Disadvantages of the Various Time Points for Implant Placement After Tooth Extraction

Classification	Advantages	Disadvantages
Type 1	• Extraction and implant placement are combined in the same surgical procedure • Reduced overall treatment time compared to types 2, 3, and 4 • Peri-implant defects often present as two- or three-walled defects, which are favorable for simultaneous bone augmentation procedures	• Morphology of the site may increase the difficulty of placing an implant in an ideal position • Morphology of the site may compromise initial implant stability • Lack of soft tissue volume makes attainment of tension-free primary closure more difficult • Increased risk of marginal mucosal recession • Inability to predict bone modeling may compromise outcomes
Type 2	• Reduced treatment time • Additional soft tissue volume allows for easier attainment of tension-free closure • Additional soft tissue volume may enhance soft tissue esthetic outcomes • Flattening of facial bone contours facilitates grafting of the facial surface of the bone • Peri-implant defects often present as two- or three-walled defects, which are favorable for simultaneous bone augmentation procedures • Allows for resolution of pathology associated with the extracted tooth	• Two surgical procedures are required • Morphology of the site may compromise initial implant stability
Type 3	• Partial bone healing usually allows implant stability to be more readily attained • Additional soft tissue volume allows for easier attainment of tension-free closure • Additional soft tissue volume may enhance soft tissue-esthetic outcomes • Peri-implant defects often present as two- or three-walled defects, which are favorable for simultaneous bone augmentation procedures • Flattening of facial bone contours facilitates grafting of the facial surface of the bone • Allows for resolution of pathology associated with the extracted tooth	• Two surgical procedures are required • Extended treatment time as compared to type 1 and type 2 placement • Socket walls exhibit varying amounts of resorption • Increased horizontal bone resorption may limit the volume of bone for implant placement
Type 4	• Bone healing usually allows implant stability to be readily attained • Additional soft tissue volume allows for easier attainment of tension-free closure • Additional soft tissue volume may enhance soft tissue esthetic outcomes • Allows for resolution of pathology associated with the extracted tooth	• Two surgical procedures are required • Extended treatment time compared to type 1, type 2, and type 3 placement • Socket walls exhibit greatest amounts of resorption • Greatest chance of increased bone resorption limiting the volume of bone for implant placement

The following parameters must be evaluated for an immediate implant placement and provisionalization procedure:

The gingival level of the failing tooth should be:

(i) at the same level as (or more coronal than) that of the contralateral tooth; and

(ii) harmonious with adjacent dentition, as some gingival recession can be expected after the procedure.[6]

Therefore, when the gingival level of the failing tooth is more apical than that of the contralateral tooth, orthodontic forced eruption is recommended before immediate implant placement and provisionalization.[7]

The osseous tissue-gingival tissue relationship can be evaluated by bone sounding and should measure 3 mm on the facial aspect of the failing tooth and 4.5 mm on the proximal aspect of adjacent teeth. There is a propensity for tissue recession after extraction, with or without immediate implant placement, in low crest situations where bone sounding measurements are greater than those indicative of an optimal relationship.[8] Depending on the level of the gingival tissue, orthodontic and/or periodontal treatment can be used to improve the osseous tissue–gingival tissue relationship.

■ Gingival biotype can be assessed during bone sounding and categorized according to the visibility of the underlying periodontal probe (SE Probe SD12 Yellow; American Eagle Instruments Inc., Missoula, MT, USA) through the gingival tissues with higher visibility corresponding to reduced thickness of tissue[9,10]. A thin gingival biotype, which has been shown to sustain more tissue recession after surgical insults than a thick biotype, can be enhanced by using a bilaminar subepithelial connective tissue graft at the time of implant placement and provisionalization.[11]

■ A sagittal root position12 of the failing tooth in the alveolar bone can be identified via cone-beam computed tomography and can be categorized as one of four different classes (Fig. 1):

- **Class I:** the root is positioned against the labial cortical plate.
- **Class II:** the root is centered in the middle of the alveolar housing without engaging either labial or palatal cortical plates at the apical third of the root.
- **Class III:** the root is positioned against the palatal cortical plate.
- **Class IV:** at least two-thirds of the root is engaging both labial and palatal cortical plates.

It is important for clinicians to recognize cases that are favorable for immediate implant placement and provisionalisation (Class I sagittal root position), cases that are more technique-sensitive and entail additional attention (Class II and Class III sagittal root position) and cases that are contraindicated for immediate implant placement and provisionalization, requiring augmentation of hard and/or soft tissue before implant placement (Class IV sagittal root position)[12]. Buccolingual width and inter-radicular mesiodistalwidths of the failing tooth determine the diameter of the implant to be used and can be evaluated using cone-beam computed tomography and periapical radiographs.

Healing and Regenerative Outcomes:

Modeling of the ridge after extraction continues to occur following implant placement. Bone augmentation procedures are effective in promoting bone regeneration with immediate and early implant placement. Bone augmentation procedures may compensate for modeling changes and may improve ridge contours. Bone augmentation procedures are more successful with immediate and early implant placement than with late placement. [4]

ADVANTAGES OF IMMEDIATE IMPLANT PLACEMENT:

- Reduced number of surgical procedures
- Immediate provisional restoration can be placed soon after implant placement hence the patient can avoid the need for interim removable prosthesis

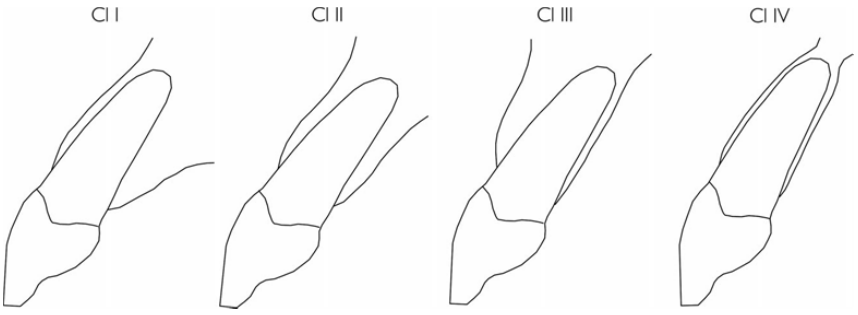

Fig. 1. Sagittal root position classification: Class I (Cl I): the root is positioned against the labial cortical plate. Class II (Cl-II): the root is centered in the middle of the alveolar housing without engaging either labial or palatal cortical plates at the apical third of the root. Class III (Cl III): the root is positioned against the palatal cortical plate. Class IV (Cl IV): at least two-thirds of the root is engaging both labial and palatal cortical plates.

• Preservation of adjacent papilla which contributes to the final esthetic outcome

• Good patient acceptance

• Immediate functional and esthetic (sculpting of soft tissues) rehabilitation of the patient

• Countersinking the implant below the crestal bone is avoided reducing the early crestal bone loss

In the esthetic area, the immediate placement of an implant and its immediate provisionalization are delicate procedures with favorable results, as demonstrated by the 5-year, multicenter, prospective evaluation by Cooper et al.[13] The authors analyzed 55 implants in fresh sockets and 58 in healed ridges. The survival rate was, respectively, 94.6% and 98.3%, with all the failures occurring in the first year. This difference was not statistically significant. The same result was noted in interproximal crestal bone levels and soft-tissue levels. The authors remark that these results could be obtained by using appropriate guidelines and with careful patient selection. Whereas, Cosyn et al.[14], in another 5-yearprospective study, found that the mean mid-facial recession increased with borderline significance between 1 and 5 years. The authors wondered if it was feasible to recommend this approach in daily practice. A recent literature review evaluated immediate implant placement and immediate restoration with a single crown in the anterior maxilla; it reported 626 implants with a success rate of 97.96% and a survival rate of 98.25% (medium follow-up: 31.2 months)[15] in accordance with the systematic review of the literature by Del Fabbro et al.[16] (30 of Kan), who reported an overall implant survival rate of 97.62% (range: 78.6–100%) after 1 year of function.

DISADVANTAGES:

• Increased technical difficulty of preparing the osteotomy to allow the implant to be placed with initial stability and in a good prosthetic position

• Increased risk of mucosal recession, which may compromise soft tissue esthetic outcomes

• Additional hard and soft tissue augmentation procedures are usually required to overcome this risk, further increasing the technical demands of the procedure

• Micromotion of the implant that can cause resultant crestal bone loss or implant failure is greater than with two-stage approach

• Secondary infections in the grafted sites and recession in the thin tissue biotype areas.

EVALUATION OF BONE LOSS AROUND IMPLANT AFTER IMMEDIATE PLACEMENT:

Several studies have described similar outcomes in the histological changes around implants after immediate implant placement, i.e., significant vertical and horizontal bone dimensional changes occurring mainly in the buccal bone plate.

Aguirre Zorzano et al.[17]in a prospective clinical study evaluated immediate temporary restoration of single tooth implants. They assessed the survival, marginal bone loss and complications around single tooth implants with immediate provisionalization. Seventy eight implants were placed in 57 patients: 56 after extraction and 22 in healed sockets. Immediately after surgery, provisional crowns were delivered without contacts in both centric and excursive jaw movements. The marginal bone loss was measured using periapical radiograph at 1 and 6 months. The mean mesial bone loss was 0.2 ± 0.4 mm and the mean distal bone loss was 0.2 ± 0.4 mm observed at 6 months. There was no statistically significant difference found between immediate or delayed implants. Sixty seven implants showed a bone loss <1 mm and 36 did not show any bone loss at all. The authors concluded that immediate restoration with single tooth implants and provisional crowns may be considered as a predictable technique.

Roe et al.[18] evaluated horizontal and vertical dimensional changes to the facial bone following maxillary anterior single tooth immediate implant placement and provisionalization using cone beam computed tomography (CBCT) study taken immediately after (T1) and 1 year after surgery (T2). Horizontal facial bone thickness (HFBT)was measured at 0, 1, 2, 4, 6, 9, and 12 mm apical to the implant platform. Vertical facial bone level (VFBL) was the perpendicular distance from the implant platform (0) to the most coronal point of the facial

Table 2: Predictive factors for immediate implant placement:

Variable	Low risk	High risk
Biotype	Thick	Thin
Gingival form	Flat scallop	High scallop
Tooth position/free gingival margin	Coronal	Ideal or Apical
Tooth shape	Square	Triangular
Position of the osseous crest : < 3mm from the adjacent teeth and facially	High crest	Low crest

bone. At T2, the mean HFBT changes -1.23 to -0.08 mm at seven different levels were evaluated. The mean VFBT changes were at -0.82 mm. The HFBT changes at 0-9 mm levels was not significantly different from one another, but they were significantly smaller than the change at 0 mm level and significantly greater than change at 12 mm level. The study concluded that dimensional changes to the peri-implant facial bone following maxillary anterior single immediate implant placement and provisionalization should be expected.

Kolerman et al.[19] in a 1-4 year retrospective study assessed radiologic and biologic parameters of immediately restored implants combined with guided bone regeneration (GBR) and free connective tissue graft (n = 34). They measured the distance from the implant shoulder to the coronal bone-to-implant contact (DIB), i.e., the mesial and distal alveolar bone crest to implant shoulder distance. After 29 months, a mean mesial bone loss of 1.10 ± 0.39 mm (range: 0.5-2.4 mm) and mean distal bone loss of 1.19 ± 0.41 mm (range: 0.4-2.1 mm) with peri-implant probing depth of 3.49 mm (SD ± 61.06)and 2.35 (SD ± 60.52) for the contralateral tooth (highly significant P < 0.001) were observed.

The authors concluded that the anterior maxillary single-tooth replacement, using GBR and connective tissue graft according to the concept of immediate implant placement and nonfunctional restoration, is an accepted treatment modality achieving favorable peri-implant soft-tissue condition. In spite of the bone deficiencies in the buccal walls of the sockets, this approach results in success rates similar to other methods of immediate loading or restoration, both clinically and radiographically.

Cristalli et al. (2015)[20] assessed the vertical distance from the most coronal point of the alveolar crest to the most apical point of the bony defect, vertical distance from the implant shoulder to the most apical point of the bony defect, and the horizontal distance from the implant surface to the socket wall at the level of the alveolar crest (n = 24). Clinical parameters, marginal bone loss, as well as pink estheticscores and white esthetic scores (PES and WES) were evaluated at 3, 6, and 12 months after implant placement. The mean marginal bone loss after 1-year follow-up was 0.383 (standard deviation [SD] ±0.749) at mesial site and 0.278 (SD ± 0.595) at distal site. The mean total PES/WESwas 17.13 ± 1.91 (range: 13–20). The authors concluded that within the limitations of this study, when careful patient selection and strict clinical protocol are observed, the immediate placement and loading of a single Nobel Active™ implant in a fresh extraction socket may be considered avaluable and predictable option in terms of implant success as well as hard- and soft-tissue stability.

The most relevant factor for measuring the horizontal bone loss was the thickness of the buccal bone wall and for vertical bone loss, bone the implant position and the buccal bone thickness significantly influenced the amount of resorptive changes. For the spontaneous filling of the gap between the implant surface and the inner bone plates, the most relevant factors are the implant (significantly better in cylindrical implants compared with the conical implants), the thickness of the buccal bone plate, and the patient (smokers performed significantly worse).

EVALUATION OF INITIAL PRIMARY STABILITY IN IMMEDIATE IMPLANT PLACEMENT:

Stability is the most important factor for the loading of an implant with prosthesis and for its success. In immediate implant cases, there is a customized socket wall for attaining good initial stability. To attain good initial stability/primary stability, implants 2 mm longer than the socket length are selected and excess preparation of 2 mm beyond the socket is performed, with initial drilling followed by sequential drilling. Therefore, the initial stability attained is primarily due to the contact of the implant-bone interface, only in the apical one-third. Selection of the implant body contour is very important to attain good initial stability. As the socket wall is tapered toward the apex, it is best to use cylindrical or straight screw implants. Drilling with drills that have exact angulation is also primarily important, as always, if the root is slightly curved, the drill goes toward the path of least resistance. Therefore, a firm grip is necessary to prepare a 2-mm implant site apically. Implants are placed into an extraction socket with the implant shoulder margin at least 2 mm below the crestal bone level.[4]

The vertical resorption can be limited by placing the implant shoulder below the level of the crestal bone. Evaluation of the crestal bone level can be performed using standardized digital periapical radiographs with the long-cone paralleling technique. In addition, it is critical to monitor the peri-implant bone changes after immediate implant placement, especially after prosthetic loading. This can be accomplished by a device that provides a three-dimensional view of the hard tissue. The recently developed CBCT scan meets these requirements, with the added benefit of decreased X-ray exposure as compared to conventional CT imaging.

EVALUATION OF ESTHETIC AND PATIENT CENTERED OUTCOMES:

Implant therapy has been evaluated in various ways over the years, starting with 'fixture survival', being the only parameter considered to judge successful therapy. Together with technical advances, esthetics, in terms of soft-tissue contour and prosthetic restoration, became another important parameter by which to judge rehabilitation. Most recently, the patient's perception of their surgery emerged as an important parameter for

comprehensive evaluation of the therapy. In the literature, there are a large number of studies but no consensus regarding the correct method to undertake this type of research.[21] Nevertheless, the available literature reports some interesting findings.

Hof et al.[22] interviewed 150 patients about their perception of implant therapy. Regarding the time of treatment, fewer interview eesanticipated a healing period of at least 2 months after tooth extraction compared with a healing period of at least 2 months after implant placement (89% and 96%, respectively) and only 12%were willing to tolerate increased risk of implant failure for the sake of shortening treatment duration. De Bruyn et al.[23] published a systematic review of oral health-related quality of life in implant dentistry, with 'quality of life' being defined as the patients' evaluation of their health in their daily lives.

Regarding the timing of implant placement, the authors found no significant differences in shortening treatment time from a patient's perspective. A10-year retrospective study analyzed the vertical dimension of vestibular bone of the one-stage post extraction implant with simultaneous bone regeneration and also evaluated patient-related parameters.[21] Seventeen patients were evaluated after 10 years using a questionnaire with a visual analog scale in aspects including chewing function, esthetic satisfaction, peri-implant soft-tissue health, access for oral hygiene, speaking ability and overall satisfaction.[24] A self-assessed score on a visual scale (of 1-10) for chewing function was 10, for esthetic appearance was 9, for mucosal health was 8, for clean sibility of the restoration was 9, for overall satisfaction was 9and for speaking ability was 9.5. Interestingly, the seen couraging results were not associated with loss of facial bone, the concern most commonly recognized in esthetic implant therapy. The authors found no correlation between vertical bone loss and the position of the facial mucosal margin or the papilla index system scores.

However, this clinical study has limitations. The radiographic images provide limited data of the facial bone volume and the vestibular bony wall; and the thickness of the peri-implant tissue at baseline was not assessed.

The Osteology Consensus Group 25 stated, in 2011, that the survival rate of post extraction implants in the esthetic area is high but there is also a very high risk of mucosal recession. Accordingly, case selection should be carried out evaluating the following potential risk factors:

- smoking.
- < 1 mm vestibular bone.
- thin biotype.
- vestibular position of the implant.

In the same way, a recent International Team for Implantology consensus statement underlines that, with immediate implant placement, the risk of mucosal recession increases.[26] The research group recommends a careful case selection, to ensure:

- intact socket walls.
- facial bone wall at least 1 mm in thickness.
- thick soft-tissue.
- no acute infection at the site.
- availability of bone apical and palatal to the socket to provide primary stability.

The use of surgical templates is suggested as well as a provisional fixed restoration. Regarding the timing of loading, the guidelines of the International Team for Implantology group are as follows 27:

- a torque of 20–45 N for immediate loading.
- no systemic health contraindication.
- more benefits than risks.

In the anterior region, immediate loading should be performed with caution and by experienced clinicians and should not be considered a routine procedure.

The American Academy of Fixed Prosthodontics 28 remarks that: “The risk–benefit of immediate loading in scenarios in which support and stability from the recipient site is diminished must be critically evaluated because of the difficulties in achieving esthetic outcomes after failure.”

CONCLUSION

Immediate implant placement is a reliable technique with implant success rates comparable to those obtained by conventional protocol. It allows a significant comfort to the patient, a reduction ofthe healing duration and a preservation of the gingival architecture; which optimizes the aesthetic outcomes. Clinical parameters and case selection should be taken into account to increase the predictability to achieve successful results.

CONFLICT OF INTEREST:

The authors declare that there is no conflict of interest.

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