Single-Tooth Replacement in the Anterior Maxilla by Means of Immediate Implantation and Provisionalization: A Review

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Objectives: *The objective of this study was to assess to what extent the outcome of immediate implantation and provisionalization for replacing single maxillary teeth in the esthetic zone is favorable and predictable from biologic and esthetic points of view.* ***Material and Methods:*** *An electronic search (MEDLINE and Cochrane Oral Health Group Specialized Trials Register) and a manual search were performed to detect studies concerning maxillary single-tooth replacements by means of dental implants immediately placed into fresh extraction sockets and provisionalized within the first 24 hours. Only full-text reports on clinical studies published in English up to June 2006 were included. Case reports and reviews on the topic of interest were excluded.* ***Results:*** *Eleven studies were selected. Based on a qualitative data analysis, implant survival and even management of papilla levels seem predictable following immediate implantation and provisionalization. However, maintaining the midfacial gingival margin may be more problematic, since postextraction bone remodeling and therefore marginal gingival changes will occur irrespective of the timing of the placement of an implant. The long-term impact of this remodeling is currently unclear and needs to be elucidated in future research.* ***Conclusion:*** *The clinician is recommended to be reserved when considering immediate implant placement and provisionalization for replacing single maxillary teeth in the anterior zone. At the very least, a number of guidelines and prerequisites need to be taken into consideration.* Int J Oral Maxillofac Implants 2008; 23:897–904

Key words: *immediate implantation, immediate loading, maxilla, single-tooth dental implants*

In many clinical cases of single tooth loss, the implant restoration has become the treatment of choice.[1–7] Its high predictability from a functional and esthetic point of view may account for this. Traditional guidelines advise that 2 to 3 months of alveolar ridge remodeling following tooth extraction and a supplementary 3 to 6 months of load-free healing are essential for implant osseointegration.[8,9] Despite the benefits of implants for replacing missing teeth, this time-consuming protocol is a disadvantage and may influence the decision to rehabilitate by means of dental implants. The reduction of healing time by immediate implant placement into fresh extraction sockets has been described in several studies. Providing good primary stability of these implants can be achieved, comparable survival rates to implants placed according to the original protocol may be expected.[10–15] Besides immediate implantation, the time gain may be further optimized by reducing or even eliminating the load-free healing period following implant placement. Several investigators have demonstrated successful immediate loading in edentulous mandibles by means of a fixed cross-arch splinted superstructure.[16–19] Their promising results have led to further studies concentrating on the progressive shortening of the healing period for maxillary multiunit implant reconstructions[20–23] and for single-tooth implants, ultimately resulting in the immediate connection of an implant-retained provisional restoration.[24–27]

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Apart from time gain, another rationale for immediate implantation and provisionalization is the potential to maximally preserve hard and soft tissues, which may be beneficial to the esthetic treatment outcome. Postextraction healing and healing from implant insertion coincide, as there is only 1 surgical phase. The standard protocol with 2 to 3 consecutive surgeries in the same site may result in more tissue damage and loss. In addition, as the original gingiva may be preserved by the instant connection of a provisional restoration offering a mechanical support to the papillae and midfacial gingival tissues, the need for additional soft tissue surgery may be eliminated.

The objective of the present study was to assess the outcome of immediate implantation and provisionalization to replace single maxillary teeth in the esthetic zone. Specific emphasis is focused on predictability from a biologic and esthetic point of view.

MATERIALS AND METHODS

Study Selection

Only full-text reports on clinical studies published in English that enclosed maxillary single-tooth replacements by means of dental implants immediately placed into fresh extraction sockets and provisionalized within the first 24 hours were reviewed. In order to be as inclusive as possible, study duration was not considered as a selection criterion. Search results were excluded for 1 or more of the following reasons: case reports, reviews, reports without actual data, or papers in which it was difficult to distinguish immediate from delayed implantation or maxillary from mandibular placement.

Outcome Variables

The outcome variables of interest were implant survival rate and changes in peri-implant hard and soft tissue levels.

Search Strategy

An electronic search was made in the MEDLINE and Cochrane Oral Health Group Specialized Trials Register databases dating back to 1977 and using October 2006 as the final date. The following combination of free text words and MeSH* terms was adopted:

Dental-Implants, Single-Tooth AND Maxilla* AND (immediate OR immediate placement OR immediate implantation) AND (provisionalization OR provisionalization OR immediate loading).*

To minimize publication bias, a complementary manual search which included a review of the past decade up to October 2006 was made of the journals *Clinical Oral Implants Research* and *The International Journal of Oral & Maxillofacial Implants*. Additionally, reference lists of the articles retrieved following a preliminary selection by the electronic and manual search were scrutinized.

Assessment of the Methodological Quality

The methodological quality of the papers was assessed, focusing on study design, description of patient demographics, and outcome variables measured.

Qualitative Data Analysis

The data were analyzed from a descriptive point of view, as only a limited number of studies in reference to the topic was retrieved and considerable heterogeneity was found between them.

RESULTS

Search Results

All search strategies provided 43 articles after eliminating titles that were present in different searches. From the 43 articles finally obtained, 11 were considered valid and 32 were excluded for the following reasons:

- Implantation into healed sites (17 articles)[24,28–43]
- No differentiation between immediate or delayed implantation or maxilla or mandible (7 articles)[28,32,35,37,42,44,45]
- Case reports (16 articles)[29,31,33,36,38,43,46–55]
- Review articles (3 articles)[56–58]
- Use of a non-standard implant design (expandable implant; 1 article)[32]
- Reports merely providing clinical guidelines without actual data (5 articles)[47,49,51,52,54]

Methodological Quality of Included Studies

In Table 1, a summary is given of the experimental characteristics and results of all included studies. In 3 studies, the reasons for tooth loss were provided,[59–61] whereas in 8 reports this information was lacking or not specified for the individual cases.[25,62–68] Five prospective studies on a single treatment strategy were included: Kan et al[60] treated 35 patients by means of maxillary immediate implantation and provisionalization and 14 consecutive patients underwent the same treatment in the report of Wöhrle.[68] Nineteen patients in the report by Cornelini et al[63] were similarly treated; an additional 3 received single-tooth implants in the mandible. The study of Ferrara et al[59] included 33 consecutive patients receiving the same treatment protocol. Groisman et al[64]

Table 1 Experimental Characteristics and Results of Clinical Studies on Immediate Implantation and Provisionalization for Replacing Single Maxillary Teeth in the Esthetic Zone

Author	No. of implants	Observation period (mo)	Implant type	Minimal insertion torque (Ncm)	Implant survival rate (%)	Hard tissue changes	Soft tissue changes
Wöhrle[68] (1998)	14	9–36	Screw-type cylindric and screw-type tapered	45	100	Max. 1 mm peri-implant bone loss†	Pre-implant status = implant status
Chaushu et al[25] (2001)	14 (8*)	6–18	Press-fit cylindric	—	78.6	Peri-implant bone loss did not extend beyond implant-abutment connection†‡	—
Hui et al[65] (2001)	13 (11*)	1–15	Screw-type cylindric and screw-type tapered	40	100	Max. 0.6 mm peri-implant bone loss†‡	—
Calvo Guirado et al[62] (2002)	9 (9*)	12	Screw-type cylindric	15	100	Peri-implant bone loss to the first thread‡	—
Kan et al[60] (2003)	35	12	Screw-type tapered	—	100	Peri-implant bone loss: Mesial: 0.26 ± 0.40 mm Distal: 0.22 ± 0.28 mm	Soft tissue loss: Mesial: 0.53 ± 0.39 mm Distal: 0.39 ± 0.40 mm Midfacial: 0.55 ± 0.53 mm
Groisman et al[64] (2003)	92	6–24	Screw-type tapered	—	93.5	Max. 2 mm of bone loss†	3 implants with more than 2 mm buccal soft tissue loss
Lorenzoni et al[61] (2003)	8 (4*)	12–14	Stepped screw-type tapered	32 Ncm	100	Peri-implant bone loss: 0.75 ± 0.50 mm‡	—
Norton[66] (2004)	16 (12*)	13–30	Screw-type cylindric	25 Ncm	100	Peri-implant bone loss: 0.22 ± 0.41 mm†	—
Cornelini et al[63] (2005)	19 (3")	12	Screw-type tapered	—	100	Peri-implant bone loss: 0.50 mm§	Midfacial soft tissue loss: 0.75 mm§
Tsirlis[67] (2005)	28 (15*)	24	Screw-type tapered	—	100	Peri-implant bone loss: 0.75 ± 1.05 mm	—
Ferrara et al[59] (2006)	33	12–52	Stepped screw-type tapered	—	93.9	No apparent bone loss	—

*Delayed implant placement.
†Peri-implant bone loss assessed on most recent radiographs.
‡Overall peri-implant bone loss on immediate as on delayed inserted implants.
§Overall peri-implant bone/soft tissue loss on maxillary as on mandibular implants.
‖Mandibular implants.
–Indicates no data.

investigated 92 single-tooth maxillary implants. Six prospective studies including data on immediately provisionalized single-tooth implants placed into fresh extraction sockets or healed sites were also considered.[25,61,62,65–67] Among them, 2 were controlled clinical studies comparing immediate to delayed implantation.[66,67] Others pooled the data on both strategies in expressing results.[25,61,62,65] Even though these reports have their merit from an exploratory point of view, they may add little valuable information on the outcome of the treatment concept of interest, as there is lack in homogeneity of study samples. In addition, 2 reports included data on adjacent teeth immediately replaced by means of provisionally restored dental implants.[25,61] Tissue alterations between 2 implants on one hand and between a tooth and an implant on the other hand may differ substantially.[69–71]

In all studies, the concept of immediate nonocclusal loading was pursued. That is, provisional restorations were cleared of all contact in centric occlusion and during eccentric movements to avoid full functional loading of the implant during healing. In 9 studies, cemented provisional restorations were used for this purpose,[25,59–62,64–66,68] whereas in 2 reports, screw-retained provisional prostheses were placed to avoid any chemical interference with the early stages of the healing process.[63,67]

Only 5 authors published results on consecutively treated cases.[25,59,60,66,68] Even though this is of the utmost importance when interpreting results, the information was not provided or was unclear in 6 reports.[61–65,67]

In 3 studies, the observation period was 12 months.[60,62,63] Tsirlis et al[67] published 2-year results on immediate implantation and provisionalization. Others included data on ongoing cases, with a variable follow-up period ranging from 1 to 52 months.[25,59,61,64–66,68] Since the time points of data collection differed, with results after 1 year, 2 years, data corresponding to the

last follow-up visit, or to the delivery of the permanent crown, it is difficult to compare the outcome of the included studies. Cautiousness in comparing data seems also imperative since different implant types were used. In 2 studies, screw-type cylindric implants[62,66] were inserted, whereas in another 4 screw-type tapered implants[60,63,64,67] were used. In 2 studies both were placed.[65,68] Two other reports described the use of stepped screw-type tapered implants.[59,61] Finally, press-fit cylindric implants were inserted in one study.[25] Besides morphology, implants differed in material: 7 used surface-treated titanium implants,[59,61–63,65–67] 3 used hydroxyapatite-coated implants,[25,60,64] and 1 used both.[68] In 5 studies, the use of a bone filler was used to fill the gap between the buccal socket wall and the implant.[25,59,64,65,67]

In most studies, patient demographics were well described. Only Groisman et al,[64] Lorenzoni et al,[61] and Wöhrle et al,[68] did not provide data on the age range of the examined population. In some studies, patients with smoking habits[25,59–61] and bruxism[59–61,63,65] were excluded. Remarkable is the fact that none of the investigators made notice of the gingival biotype in describing the profile of the included patients. It has been documented that gingival levels are influenced by their biotype. That is, patients with a thin-scalloped gingival biotype are more prone to develop gingival recessions as compared to those with a thick-flat biotype.[72,73]

All investigators recorded implant survival rate. An attempt was made to describe the amount of peri-implant bone loss, but exact data were only provided in 5 articles.[60,61,63,66,67] Recordings of esthetic outcome variables were scarce: data on changes in peri-implant mucosa levels were found in 2 studies.[60,63] Kan et al[60] described changes in papillae and midfacial gingival levels in reference to a line connecting the midfacial gingival levels of the 2 adjacent teeth. This was performed on the basis of color slides obtained by handheld photography. Cornelini et al[63] adopted the same technique to describe variations in midfacial gingival levels; data were collected at chairside. An ordinal-scaled index (Jemt's index[74]) was used to document papilla height.

Treatment Outcome from a Biologic Viewpoint: Implant Survival Rate

Table 1 summarizes the outcome of the treatment strategy of interest for each of the included studies. An implant survival rate of 100% in the short term was described in all but 3 studies: Chaushu et al[25] achieved osseointegration in only 78.6% of the cases, whereas Ferrara and et al[59] achieved 93.9% and Groisman and et al[64] reported 93.5%.

Treatment Outcome from an Esthetic Viewpoint: Hard and Soft Tissue Changes

Scrutinizing the results in Table 1 on immediately placed and provisionally restored single-tooth maxillary implants indicates a mean peri-implant bone loss ranging from 0.2 mm to 0.5 mm at 1 year follow-up.[60,63,66] Several implants in the study by Kan et al[60] showed bone gain, which is in accordance with findings from Norton et al,[66] who described no bone loss to bone gain in 37.5% of the implants placed according to the immediate implantation and provisionalization protocol. Note that the mean bone loss of 0.75 mm after 12 to 14 months of follow-up in the study by Lorenzoni et al[61] relates to both immediately placed implants and implants inserted into healed sites. The study of Tsirlis et al[67] yielded an average peri-implant bone loss of 0.75 mm after a 2-year observation period.

Two research centers published 1-year data on soft tissue changes following immediate implantation and provisionalization. Kan et al[60] reported a mean loss in papilla height between 0.39 mm and 0.53 mm. In the study by Cornelini et al,[63] 61% of the papillae received a score of 2 according to Jemt's index[74] (at least half of the height of the papilla is present), and 39% presented a score of 3 (the papilla fills up the entire proximal space) at study termination. It is not clear from the study, however, how these scores relate to the height of the papillae prior to removal of the tooth. An average midfacial gingival recession between 0.55 mm and 0.75 mm can be expected after 1 year of follow-up.[60,63]

DISCUSSION

The concept of immediate implantation and provisionalization for replacing single teeth in the premaxilla comes with some obvious benefits: As it combines tooth extraction, implant surgery, and restorative treatment, the time gain can be optimized. At least from a theoretical point of view, hard and soft tissues may be maximally preserved, since there is only one surgical phase and a provisional restoration offers an instant mechanical support to the papillae and midfacial gingival tissues.

In the past, osseointegration as determined by implant survival was the main criterion for success of any implant-supported restoration. From such a viewpoint, it seems that immediate implantation and provisionalization is a satisfactory and predictable treatment concept, since all but 3 studies yielded 100% implant survival. This success rate is at least comparable to data published for single-tooth implants placed according to the standard protocol in healed sites.[75]

Still, one should be aware that the promising results in this review article only relate to a limited number of implants that may not have been necessarily all consecutive cases. The low implant survival rate of 78.6% described by Chaushu et al[25] for immediate implantation and provisionalization may have been the result of using press-fit implants.

As the criteria for success have changed during the past decade in the interest of an esthetic treatment outcome, implant dentistry has strongly evolved from a bone-driven surgical protocol to a restoratively and biologically driven protocol. To optimize esthetics, preservation of hard and soft peri-implant tissues is mandatory. The results of this study on immediately placed and provisionally restored single-tooth maxillary implants indicate a mean peri-implant bone loss between 0.2 mm and 0.5 mm at 1 year follow-up,[60,63] with ongoing loss thereafter reaching an average 0.75 mm crestal bone loss at 2 years follow-up according to one study.[67] These data seem lower as compared to earlier published data on submerged implants showing peri-implant bone loss of about 1 mm during the first year.[1,6,75–77] Hence, the concept of immediate implantation and provisionalization seems at least as favorable as the standard protocol in preserving hard tissues, at least in the short term. Still, as advantageous as this observation may be, the key point in maintaining interdental papillae may be the bone level to the adjacent tooth. Providing that this bone peak is preserved during extraction of the hopeless tooth and implant surgery, the papilla height can be secured.[69,70,78,79] Hence, the results described by Kan et al[60] and Cornelini et al[63] on the limited loss of papilla height following immediate implantation and provisionalization are not that surprising, as they may be more related to the presence of the bone peak to the adjacent tooth than to the surgical and/or restorative strategy. At least when comparing early to delayed placement of single-tooth implants, it has been shown that there is no difference in papilla height after 1.5 years of follow-up.[80]

Even though it was previously believed that implant placement into fresh extraction sockets would prevent remodeling and hence maintain the original shape of the ridge,[81] recent reports have failed to support this.[82–84] Animal and human studies have shown that irrespective of the placement of an implant, postextraction bone remodeling will occur, resulting in horizontal and vertical loss.[82–84] In addition, bone loss will be more pronounced on the buccal than on the lingual aspect of the ridge. This is explained by the fact that the buccal bone crest is solely comprised of bundle bone, which entirely resorbs following tooth removal. In contrast, the lingual crest is built up by cortical bone on the outer surface, preventing excessive loss. These inevitable bone changes may be detrimental for the management of the midfacial gingival margin when implants are placed into fresh extraction sockets. Although currently available studies report a limited midfacial gingival recession between 0.55 mm and 0.75 mm at the 1-year follow-up,[60,63] lack of long-term results make conclusions premature. In addition, these 1-year data have been described in reference to a line connecting the midfacial gingival levels of the 2 adjacent teeth. Since this line is not necessarily stable over time, as it is subjected to the healing process, inflammation, and so on, a standardized measuring technique using fixed reference points would be preferable in future research. In light of these observations and comments, immediate implant placement should not be the treatment concept of choice for patients with a thin-scalloped gingival biotype in which buccal bone resorption may easily result in excessive midfacial gingival recession. In these high-risk patients, a staged procedure is more predictable and therefore preferable. In contrast, the risk for esthetic failure may be limited in patients with a thick-flat biotype. Here immediate implant placement can be considered. Still, it is believed that in the interest of a predictable esthetic treatment outcome for these patients in the long run, implant surgery should include filling the marginal void between the implant and the buccal socket wall using a bone filler with a low substitution rate until this procedure is shown to be redundant by controlled clinical studies. Another guideline when considering immediate implant placement and provisionalization is the use of surface-treated implants, as these provide the highest bone-implant contact, which is beneficial to rapid osseointegration.[85–90] In addition, it is easier to achieve primary stability using screw-type tapered implants instead of screw-type cylindric implants. Still, there has been no consensus yet on the minimal insertion torque for the treatment concept discussed in this paper.

There are a number of prerequisites that need to be fulfilled when immediate implantation and provisionalization are considered for replacing single maxillary teeth in the esthetic zone. First, immediate implant placement may be adversely affected by the presence of infection.[91] In that case, more standard procedures should be followed. Second, establishing good primary stability must be a major concern, as it is for the standard implant placement protocol. This can only be granted when long implants are used, crossing the apical portion of the extraction socket. Thus, sufficient bone volume in this area is an important prerequisite. Third, immediate provisionalization

should not be performed in cases of buccal bone defects extending to the buccal crest. These situations require hard tissue grafting and the use of barrier membranes over the alveolar ridge making the connection of a restoration to the implant impossible at the time if even immediate implantation is performed. In addition, the extraction alveolus can complicate implant placement, especially when the prosthetic superstructure obliges the surgeon to deviate from the axis of the alveolus. As this requires surgical skills, operator experience is another prerequisite. A final concern may be of restorative nature: occlusion and articulation might obstruct every intention to clear the provisional restoration of all contact. In these cases, the standard protocol should be followed.

In conclusion, the concept of immediate implantation and provisionalization for replacing single teeth in the premaxilla seems appealing for the clinician. Indeed, implant survival and even managing papilla levels seem predictable following this treatment strategy. This should not be surprising, as these variables are not primarily influenced by the surgical/restorative procedure by itself. However, maintaining the midfacial gingival margin seems less predictable, since postextraction bone remodeling, and therefore, marginal gingival changes, will occur irrespective of the placement of an implant. Since the currently available information on this topic is very scarce, with a total lack of long-term results, the clinician should be reserved when considering immediate implant placement and provisionalization for replacing single maxillary teeth in the esthetic zone. At the very least, a number of guidelines and prerequisites need to be taken into consideration. More long-term prospective and controlled clinical studies are mandatory to document the esthetic treatment outcome of this treatment strategy. In addition, a standardized technique to measure changes in gingival levels is promoted in future research.

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