Flapless Surgery and Its Effect on Dental Implant Outcomes

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Purpose: *The aim of this article was to review the current literature with regard to the efficacy and effectiveness of flapless surgery for endosseous dental implants. The available data were evaluated for short- and long-term outcomes.* ***Materials and Methods:*** *A MEDLINE search was conducted on studies published between 1966 and 2008. For the purpose of this review, only clinical (human) studies with five or more subjects were included, and clinical opinion papers were excluded. Clinical studies or reports were further rated in terms of the level or weight of evidence using criteria defined by the Oxford Center for Evidence-Based Medicine in 2001.* ***Results:*** *The available data on flapless technique indicate high implant survival overall. The prospective cohort studies demonstrated approximately 98.6% (95% CI: 97.6 to 99.6) survival, suggesting clinical efficacy, while the retrospective studies or case series demonstrated 95.9% (95% CI: 94.8 to 97.0) survival, suggesting effective treatment. Six studies reported mean radiographic alveolar bone loss ranging from 0.7 to 2.6 mm after 1 year of implant placement. Intraoperative complications were reported in four studies, and these included perforation of the buccal or lingual bony plate. Overall, the incidence of intraoperative complications was 3.8% of reported surgical procedures.* ***Conclusion:*** *Flapless surgery appears to be a plausible treatment modality for implant placement, demonstrating both efficacy and clinical effectiveness. However, these data are derived from short-term studies with a mean interval of 19 months, and a successful outcome with this technique is dependent on advanced imaging, clinical training, and surgical judgment.* Int J Oral Maxillofac Implants 2009;24(suppl):118–125

Key words: *dental implants, flapless surgery, implant complications, implant success, literature review, meta-analysis*

In the late 1970s, Brånemark established the use of extensive surgical flaps to visualize the surgical field during implant surgery.[1] According to this protocol, an incision in the mucosa or the mucobuccal fold was made, and then a flap was reflected to expose the underlying bone. The implants were then placed and the flaps repositioned with sutures.[1–3]

Over the past three decades there have been several alterations to this flap design, now integrating esthetic considerations in the critical esthetic zones of the dentition. In situations with limited bone quantity, the elevation of a mucoperiosteal flap can facilitate implant placement by allowing the surgeon to visually assess bone quantity and morphology at the site. The feasibility of achieving an ideal implant position in conjunction with primary stability and maximum bone-to-implant contact could then be assessed. Furthermore, visualization of the surgical field with flap elevation may reduce the risk of occurrence of bone fenestrations and dehiscences. However, flap elevation is always associated with some degree of morbidity and discomfort, and requires suturing to close the surgical wound. In the early 1970s, studies demonstrated a correlation between flap elevation and gingival recession, as well as bone resorption around natural teeth.[4] Furthermore, there has been a report of postsurgical tissue loss from flap elevation, implying that the use of flap surgery for implant placement may negatively influence implant esthetic outcomes, especially in the anterior maxilla.[5]

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Over the past 30 years, flap designs for implant surgery have been modified, and more recently the concept of implant placement without flap elevation and exposure of the bony tissues was introduced. Flapless procedures have already been used for some time with tooth extractions and site preservation, and have shown less morbidity.[6] In addition, surgeons have also considered a flapless approach for immediate implants in order to preserve the vascular supply and existing soft tissue contours.[7] Surgeons use either rotary instruments or a tissue punch to perforate the gingival tissues to gain access to bone.

Over the past few years, dental radiographic imaging has made large technological advances, with sophisticated compilations of three-dimensional (3D) imaging in the form of computed tomography (CT) as well as newly developed dental implant treatment planning software allowing 3D evaluation of potential implant sites. These new developments have contributed to the popularization of flapless implant surgery. Although the flapless technique was initially suggested for and embraced by novice implant surgeons, a successful outcome often requires advanced clinical experience and surgical judgment.[7]

Flapless surgery has several potential advantages, including *(1)* reduction of complications at the patient level, ie, swelling and pain, *(2)* reduction of intraoperative bleeding, *(3)* reduction of surgical time and need for suturing, *(4)* preservation of soft and hard tissues, and *(5)* maintenance of blood supply.

However, despite these advantages, the flapless technique also has several potential shortcomings. These may include *(1)* the inability of the surgeon to visualize anatomical landmarks and vital structures, *(2)* the potential for thermal trauma to the bone due to limited external irrigation during preparation of the osteotomy with guided surgery, *(3)* an inability to ideally visualize the vertical endpoint of the implant placement (too shallow/too deep), *(4)* decreased access to the bony contours for alveoloplasty, *(5)* difficulties in performing an internal sinus lift with a stabilized template (screw fixated), and *(6)* inability to manipulate the circumferential soft tissues to ensure the ideal dimensions of keratinized mucosa around the implant. The importance of keratinized mucosa around implants is debated, as some studies have shown that the absence of keratinized gingiva is not critical to the health of the gingiva and the implant outcome,[8,9] while others suggest that the failure rate is higher when there is a lack of keratinized gingiva or only a small amount is present.[10–15]

The aim of this review was to evaluate the current literature with regard to the efficacy of flapless surgery for endosseous dental implants.

MATERIALS AND METHODS

Literature Review

For the purpose of this review, a literature search was conducted using the MEDLINE database for the interval 1966 to August 28, 2008, in the English language. Citations were searched by key word or title using the following combinations of words: *flapless* or *incisionless* or *minimally invasive* in combination with *dental implants*. In addition, key dental journals (ie, dental implant, oral and maxillofacial surgery, periodontics, and prosthodontics) from the same interval were hand-searched to identify pertinent citations. Studies were classified by subject (animal versus human) and design (preclinical, case report, case series, cohort, clinical trial, or meta-analysis). For the purpose of this review, only clinical (human) studies with five or more subjects were included, and clinical opinion papers were excluded. Clinical studies or reports were further rated in terms of the level or weight of evidence using criteria defined by the Oxford Center for Evidence-Based Medicine.[16]

The data from the identified studies were tabulated in an extraction table according to the following criteria: study design, number of patients, number of dropouts, mean/average age, follow-up periods, type of implant case, primary and secondary outcomes, intraoperative and postoperative complications, and implant failures.

For the purpose of this article, the term *conventional implant surgery* encompasses surgical procedures that involve elevation of a mucoperiosteal flap for the preparation of the implant osteotomy and implant placement. *Flapless implant surgery* is defined as a surgical procedure used to prepare the implant osteotomy and to place the implant without elevation of a mucoperiosteal flap.

Search Results

Following the preliminary identification of 110 articles, 17 studies were identified as meeting the inclusion criteria. One of these studies was a systematic review not presenting primary evidence, and was therefore excluded. Of the remaining 16 articles, 2 were comparative cohort studies (level 2) primarily designed to document immediate postoperative clinical courses. The remaining 14 articles included 7 prospective cohort studies (level 2) and 7 retrospective or case series studies (level 4) that evaluated clinical outcomes related to implant survival and other clinical parameters (Table 1).

Two of the studies were short in duration (< 7 days) and were designed to assess intraoperative or postoperative morbidity or complications (level 2 for intended objectives).[17,18] The other 14 studies

Table 1 Study Demographics

Study	Study design	No. of patients	No. of dropouts	No. of implants after dropout	Age range (y)	Mean age (y)	Follow-up period (max)
Becker et al (2005)[22]	Prospective cohort	57	0	79	24–86	NR	24 mo
Campelo and Camara (2002)[21]	Retrospective cohort	377	18	770	27–83	54.7	60 mo
Cannizzaro et al (2007)[23]	Prospective cohort	35	0	202	39–70	56.6	12 mo
Fortin et al (2006)[18]	Prospective comparative cohort	60	0	152	19–82	NR	6 d
Malo et al (2007)[24]	Prospective cohort	23	0	92	NR	NR	21 mo
Nkenke et al (2007)[17]	Prospective comparative cohort	10	0	NR	NR	65	7 d
Oh et al (2006)[25]	Nonrandomized trial	24	0	24	25–72	45	6 mo
Ozan et al (2007)[26]	Case series	5	0	14	NR	NR	14 mo
Rao and Benzi (2008)[27]	Prospective cohort	46	1	50	22–66	42	12 mo
Rocci et al (2003)[28]	Prospective cohort	46	0	97	24–77	51	36 mo
Sanna et al (2007)[29]	Retrospective cohort	30	4	183	38–74	56	26.4 mo
Sennerby et al (2008)[30]	Retrospective cohort	43	0	117	NR	50	18 mo
van Steenberghe et al (2005)[31]	Prospective	27	3	164	34–89	63	12 mo
Wittwer et al (2006)[33]	Prospective cohort	20	0	80	53–75	61.4	4 mo
Wittwer et al (2007)[32]	Prospective cohort	20	0	80	56–77	64.3	0 mo
Wittwer et al (2007)[34]	Prospective	25	3	88	55–77	62.1	25 mo
Total		848		2,192			

NR = not reported.

reported on long-term clinical outcomes. Of these studies, 7 were prospective cohorts (level 2). The other 7 studies were retrospective studies or case series (level 4). The majority of studies included guided surgical techniques in their treatment planning (11 of 16). The study designs differed with respect to the treatment of complete edentulous arches and single sites (Table 2).

RESULTS

Morbidity and Patient Comfort

During implant surgeries, surgical trauma and patient morbidity should be confined to a minimum.[19] One technique that can be used to achieve this is flapless implant placement, which was described several years ago as a surgical technique for the edentulous mandible.[20] Unfortunately, the available literature comparing patient morbidity resulting from flapless implant surgery and conventional implant surgery was limited to two studies.[17,18] Also, additional objective assessments of short-term postoperative complications (eg, edema) were not routinely reported.

Nkenke et al[17] evaluated the differences in patient morbidity between flapless and conventional implant surgery using a questionnaire, and determined the differences in visible facial swelling of the upper lip and cheeks using optical 3D imaging. Ten patients were assigned to either the flapless or the conventional group. All patients were edentulous in the maxilla, and six implants were placed in each patient with the respective technique. Immediately after surgery, 1 and 7 days postoperatively, the patients were asked to evaluate pain and discomfort using a visual analog scale (VAS). Within the same day, an optical 3D image was assessed. In this small study, the flapless surgery reduced the amount of pain and postoperative swelling significantly ($P < .05$).

In another study, Fortin et al[18] assessed the postoperative discomfort and use of analgesics after flapless or conventional implant surgery. Sixty patients were randomly assigned to one of the above-mentioned techniques for implant placement. The patients used a VAS to describe their postoperative pain, starting on the day of surgery and daily thereafter for a total of 6 days. Along with the VAS evaluation, the patients were asked to report their use of analgesics postoperatively. The patients in the flapless group experienced significantly less pain ($P < .01$) than the patients in the conventional group. In addition, the flapless group also used less analgesics and for a shorter period of time.

Implant Survival

The 14 studies that evaluated long-term outcome[21–34] included a total of 778 patients and 2,040 dental implants over a mean observational period of 19 months (see Table 1).

In general, the data showed a high survival rate for the evaluated patient pool. The prospective cohort studies demonstrated approximately 98.6% survival (95% CI: 97.6 to 99.6), suggesting clinical efficacy, while the retrospective studies or case series demon-

Table 2 Case Types and Outcomes

Study	Single-tooth	Partially edentulous	Completely edentulous	Maxilla	Mandible	Outcome 1	Outcome 2
Becker et al (2005)[22]	NR	NR	NR	47 (implants)	32 (implants)	No significant changes in PD, BI from 1 to 6.5 mo	Radiographic bone loss = 0.07 mm, not significant
Campelo and Camara (2002)[21]	NR	NR	NR	282 (implants)	488 (implants)	Implant failure overall 37 (4.8%) over 10 y	No analgesic use: 90%
Cannizzaro et al (2007)[23]	0	0	33	33	0	Pain: none–slight (79%), moderate–severe (21%)	Postsurgical swelling: none–slight (58%), moderate–severe (42%)
Fortin et al (2006)[18]	NR	NR	NR	NR	NR	Pain (VAS): significant less and of shorter duration pain in flapless group, significant fewer analgesics in flapless	NR
Malo et al (2007)[24]	0	0	23	18	5	Implant survival = 98%; maxilla 97%; mandible 100%	Radiographic bone loss = 1.9 mm at 12 mo
Nkenke et al (2007)[17]	0	0	10	0	10	Pain (VAS) (6 h, 1 d, 7 d); AUC analysis significant less pain in flapless group vs flap over 7 d	Postsurgical swelling (days 1 and 7); significant less facial edema in the flapless over 7 d
Oh et al (2006)[25]	24	0	0	24	0	Trend for Papillary Index (PPI) to increase over 6 mo	No changes in ML, PD, mPI, mBI, WKM
Ozan et al (2007)[26]	NR	NR	NR	Yes	Yes	5 of 5 implants survived at average 9 mo	NR
Rao and Benzi (2008)[27]	46	46	0	0	46	Radiographic bone loss = 1.12 mm at 12 mo and 0.89 mm at 24 mo	NR
Rocci et al (2003)[28]	27 (implants)	70 (implants)	0	97 (implants)	0	Cumulative survival rate: 91% at 36 mo	Radiographic bone loss; 1.0 mm at 12 mo, 0.4 mm at 24 mo, 0.1 mm at 36 mo
Sanna et al (2007)[29]	0	0	30	26	4	Radiographic bone loss at 4 y: 2.64 mm smokers; 1.3 mm nonsmokers	Cumulative survival rate 91.5% over 66 mo
Sennerby et al (2008)[30]	18 (implants)	99 (implants)	0	45 (implants)	72 (implants)	> 2 mm radiographic bone loss at 53% implants; > 3 mm radiographic bone loss at 37% implants	NR
van Steenberghe et al (2005)[31]	0	0	27	27	0	Radiographic bone loss 1.2 mm at 12 mo	NR
Wittwer et al (2006)[33]	0	0	80	0	80	NR	NR
Wittwer et al (2007)[32]	0	0	20	0	20	NR	NR
Wittwer et al (2007)[34]	0	0	25	0	25	Success rate = 97.7%	NR

PD = probing depth; BI = bleeding index; ML = attachment level, mPI = modified plaque index; mBI = modified bleeding index; AUC = area under curve; WKM = width of keratinized mucosa; NR = not reported.

strated 95.9% survival (95% CI: 94.8 to 97.0), suggesting effective treatment.

Interestingly, one group of authors[33] associated the only two implant failures (n = 78 implants) with the limitations of the transmucosal flapless technique rather than with the navigated surgical protocol for the implant placement. The authors noted that this technique might not be suitable for all bone morphologies.

Marginal Bone Loss

The radiographic marginal alveolar bone loss over 1 year ranged from 0.7 mm[29] to 2.6 mm.[30] Six of the studies[24, 27–31,35] included a documented 12-month follow-up of the marginal bone loss. Four of the studies [24,27,29,31] evaluated the flapless surgical approach utilizing guided surgery in edentulous arches. In addition, the implants placed in these studies were all immediately loaded.

One of these studies[29] compared smokers (13 patients) and nonsmokers (7 patients) with regard to their annual bone loss after flapless implant insertion utilizing guided surgery. Sanna et al[29] did not observe significant changes in the mean marginal bone levels between smoking and non-smoking patients at baseline and after a 1-year follow-up (smokers—*baseline* 0.1 mm [SD 0.4 mm], *1 year* –1.1 mm [SD 1.4 mm]; nonsmokers—*baseline* 0.1 mm [SD 0.5 mm], *1 year* –0.8 mm [SD 1.1 mm]).

There was only one study[30] that compared the average marginal bone loss occurring with conventional versus flapless implant surgery. The authors reported slightly less bone loss for the flapless approach (–2.1 mm, SD 1.4 mm; n = 70 implants) versus the conventional approach (–2.8 mm, SD 1.5 mm; n = 39 implants).

Noteworthy was the marginal bone loss in one specific study[30] that reported a mean bone loss of 3 mm (SD 1.4 mm) after a follow-up of more than 12 months (n = 22 implants). The authors of this study also remarked that of all implants placed (n = 109), 27% demonstrated more than 2 mm bone loss, and 14% more than 3 mm bone loss over time. There was less bone loss noted for implants placed with conventional flap elevation and with a delayed loading protocol. The authors concluded that immediate loading and a flapless surgical approach for the one-piece implant used in the study were potential risk factors for failure for this implant type.[30]

Soft Tissue Changes

Only two of the included studies reported soft tissue changes.[25,35] Oh et al[25] randomly assigned patients to one of two groups: immediate loading or delayed (after 4 months) loading. A flapless approach was chosen for both groups. The authors assessed probing depths, modified bleeding index, modified plaque index, and the width of keratinized gingiva. There were no significant differences between the groups at each time and over 6 months.

In another study,[22] 79 implants were placed via the flapless approach with a delayed loading protocol. Probing depths were measured at baseline and up to 1 month after the delivery of the final restoration. The change between those two time points was clinically insignificant (baseline 2.2 mm [SD 0.9 mm]; up to 1 month 2.3 mm [SD 0.8 mm]).

Intraoperative Complications

Four studies evaluated intraoperative complications, including perforation of the buccal or lingual bony plate.[21,23,32,33] In addition, the aforementioned studies also included incidences of primary stability at the time of implant placement, which forced the surgeons to remove or submerge these implants in the given situation.

The overall incidence of intraoperative complications was 3.8% for the reported surgical procedures. However, it should be noted that the majority of the aforementioned complications were clustered in one specific study.[21] In the study by Campelo and Camara,[21] 770 dental implants were placed in edentulous and partially edentulous arches, all utilizing a flapless approach, and the patients were followed for 10 years. For each patient, the surgeons either obtained a CT scan or used a two-dimensional radiograph (eg, periapical radiograph) for diagnostic purposes prior to the surgical intervention. A surgical stent was routinely used during the procedure. However, the authors noted 21 fenestrations, and in these situations the authors altered the surgical protocol and performed a guided bone regeneration procedure at the time of implant placement. Dehiscences of the bone occurred for 15 implants, either resulting in an alteration of the selection of the implant site or in a delay of the implant placement in that specific site for 3 months after healing.

Presence or absence of perforations of the bone was not reported in the majority of the studies. As only 4 of 16 studies account for these intraoperative complications, the data should be interpreted with caution (Table 3).

DISCUSSION AND CONCLUSIONS

This systematic review evaluated the efficacy and clinical effectiveness of flapless surgery. Of the 17 studies identified as meeting the inclusion criteria, 1 of these was a systematic review not presenting pri-

Table 3 Complications and Failures

Study	Intraoperative complications	Postoperative complications: outcome measure	No. of implant failures	No. of biological complications	No. of technical complications	No. of esthetic complications
Becker et al 2005[22]	NR	NR	1	0	NR	NR
Campelo and Camara 2002[21]	36 perforations (21 fenestrations, 15 dehishences)	NR	37	NR	NR	NR
Cannizzaro et al 2007[23]	1 perforation 1 treatment aborted	NR	2	5 (intermittent pain = 1, hyperplastic tissue = 1 , peri-implant mucositis = 1, peri-implant peri-implantitis = 2); all < 10 mo and resolved	10 (unrelated to flapless placement)	NR
Fortin et al 2006[18]	NR	NR	0	NR	NR	NR
Malo et al 2007[24]	NR	0	2	0	8 (fracture of acrylic denture)	NR
Nkenke et al 2007[17]	NR	NR	NR	NR	NR	NR
Oh et al 2006[24]	NR	NR	3	NR	NR	2 (patient subjective; patient elected to have prosthetic redone)
Ozan et al 2007[26]	NR	NR	NR	NR	NR	NR
Rao/Benzi 2008[27]	NR	0	0	0	7 (5 screw loosening and 2 crown fractures)	NR
Rocci et al 2003[28]	NR	NR	9	NR	NR	NR
Sanna et al 2007[29]	NR	NR	9	NR	NR	NR
Sennerby et al 2008[30]	NR	NR	6	6 (same failed; immediate loading with flapless)	NR	NR
van Steenberghe et al 2005[31]	NR	marginal fistula (1), resolved	0	4 (inflamed hyperplastic gingiva)	4 (2 occlusal material fracture, 1 screw loosening, 1 patient decision for different prosthesis)	NR
Wittwer et al 2006[33]	2 perforations	NR	NR	2 (2.5%)	0	2 (implants not placed where intended)
Wittwer et al 2007[32]	2 treatments aborted (perforations, instability)	NR	NR	NR	NR	NR
Wittwer et al 2007[34]	NR	4 implants loose with immediate loading, all submerged, 2 lost	2	0	NR	0

NR = not reported.

mary evidence, and was therefore excluded. Of the remaining 16 articles, 2 were comparative cohort studies (level 2) primarily designed to document immediate postoperative clinical courses. The remaining 14 articles—7 prospective cohort studies (level 2) and 7 retrospective or case series studies (level 4)—evaluated clinical outcomes related to implant survival and other parameters (see Table 1).

All studies that assessed clinical implant performance utilized extensive presurgical planning, with the majority of the studies specifically utilizing computer-assisted planning.

The data extracted from the two studies documenting the postoperative clinical course demonstrated a statistically significant reduction in immediate postoperative discomfort, duration of discomfort, facial edema, and the use of analgesics when flapless surgery was performed.[17,18] Based on this preliminary and limited information, flapless surgery may have benefits in decreasing patient discomfort in the immediate postoperative period.

Information gathered from assessing the clinical performance of implants in the remaining 14 studies, which had a mean observation period of 19 months, showed high survival for implants placed utilizing a flapless technique. A 98.6% survival rate (95% CI: 97.6 to 99.6) based on the prospective cohort studies suggest clinical efficacy of the technique. The retrospec-

tive studies or case series demonstrated a 95.9% survival rate (95% CI: 94.8 to 97.0), suggesting effective treatment.

At this time, long-term data comparing soft tissue responses with flapless and conventional surgery are unavailable.

Complications with flapless surgery may be intraoperative, postoperative, or delayed (see Table 3). Four studies reported intraoperative complications, with perforation of the buccal or lingual bony plate occurring in 3.8% of surgical procedures; however, one should note that the majority of the complications were clustered in a single study.[21] Furthermore, the presence or absence of perforations was not reported in the majority of studies, and it is unclear what implications perforations may have for implant survival or occurrence of complications. Immediate postoperative and delayed complications appear to be similar to those encountered with a conventional surgical approach.

One limitation of this review is that the flapless surgical approach for implant placement was utilized in different clinical scenarios. This technique was employed for navigation and 3D guided surgery as well as for standard surgical protocols, which may or may not include the use of a surgical stent or guide. In addition, the loading protocols for the implants varied greatly in the 16 studies, and included immediate, delayed, and conventional loading. All of these factors, in addition to other confounding elements, have implications for the outcome of any given surgery, so it is questionable to extrapolate the clinical outcomes without considering the aforementioned variables.

Overall, to accurately assess the merits of the flapless technique, more studies with similar loading protocols that objectively compare conventional surgery with a flapless approach are needed.

Importantly, the available short-term data demonstrate that flapless surgery, initially recommended for novice surgeons, actually requires more experience and presurgical planning than was originally assumed. Furthermore, this technique is often more demanding than the conventional surgical approach. Therefore, the use of flapless implant placement as a "routine" procedure in daily practice is not recommended.

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