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A systematic review of marginal soft tissue at implants subjected to immediate loading or immediate restoration

Key words: dental implants, immediate loading, immediate restoration, oral implants, peri-implant mucosa, systematic review

Abstract

Objectives: The objective of this systematic review was to critically evaluate marginal soft-tissue aspects at implants subjected to immediate loading or immediate restoration.

Methods: An electronic Medline search from 1966 up to August 2005 was conducted to identify prospective and retrospective studies on immediate implant loading. The search strategy was complemented by hand searching in peer-reviewed journals. Studies reporting on soft-tissue aspects at implants subjected to immediate loading or immediate restoration and with a follow-up time of at least 1 year were included. Assessment of identified studies and data extraction was performed independently by two reviewers. An attempt was made to isolate and categorize studies with similar protocols in order to identify trends and relevant factors. Variables that were considered included marginal and interproximal soft-tissue stability, marginal plaque accumulation, probing depth, bleeding on probing, peri-implant mucositis and peri-implantitis.

Results: From an initial yield of 581 titles, 240 articles were selected for-text analysis, finally resulting in 17 studies that met the inclusion criteria. Six studies on immediate implant loading or restoration were controlled studies, whereas the remainder was prospective case series. Seven studies reported on a 1-year data, and the longest follow-up within the included studies was 4 years. The total number of patients treated within the 17 studies was 432 including a total 706 implants studied. Overall, the articles reported on many different procedures and follow-up times, time points and evaluated soft-tissue parameters varied considerably between the different articles.

Conclusion: Within the limits of the evaluated data it can be cautiously concluded that once immediately loaded or restored implants integrate successfully, they appear to show a soft-tissue reaction with regard to periodontal as well as morphologic aspects comparable with those of conventionally loaded implants. However, follow-up periods are generally short, number of patients and/or implants per study are few, and most studies present only limited data on peri-implant soft-tissue evaluation. More accurate long-term studies with a stronger study design (i.e., RCT) reporting more detailed on treatment and follow-up protocols are required to allow for proper comparisons and conclusions.

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Today, traditional staged protocols seem to be more and more replaced by faster, one-step surgical protocols (i.e., immediate implants or even immediately restored/loaded implants). With regard to the event of osseointegration, numerous studies have documented for immediately restored implants in properly selected indications a comparable high success rate as established using late loading concepts (Chiapasco et al. 1997; Tarnow et al. 1997; Ericsson et al. 2001; Romeo et al. 2002; Engstrand et al. 2003; Glauser et al. 2005). However, when focusing on the overall treatment outcome, success is not only defined by established and maintained osseointegration. Stable peri-implant tissues (i.e., marginal bone levels and soft-tissue contours) over time are decisive for long-term success.

The placement of a temporary restoration the day of implant surgery may offer esthetic, psychological and functional advantages as compared with the use of a provisional removable prosthesis. An

immediate provisionalization also eliminates the need of a second-stage surgery, thereby reducing patient's discomfort. In addition, the length of the treatment may be reduced because soft-tissue heals simultaneously with hard tissue integration. On the other hand, if the provisional restoration is placed following osseointegration and abutment connection in a traditional staged manner, an additional 3–6 months healing period is needed for soft-tissue maturation.

Today, several classic and systematic reviews on the reliability of immediate implant loading for various clinical indications have been published (Gapski et al. 2003; Chiapasco 2004; Ganeles & Wismeijer 2004; Morton et al. 2004; Attard & Zarb 2005). Despite the increasing number of publications on the topic of immediate implant restoration, much controversy still exists over the reliability of the reported data because the publications are frequently of insufficient methodological quality (insufficient sample size, insufficient follow-up time, lack of well-defined inclusion and exclusion criteria, lack of a control group, etc.). Moreover, soft-tissue aspects at implants subjected to immediate loading or restoration have been reported and reviewed only on a marginal basis.

Objectives

The objective of this systematic review was to critically evaluate marginal soft-tissue aspects at implants subjected to immediate loading or immediate restoration.

Material and methods

Definition of immediate implant loading or restoration

Two earlier consensus meeting reports have stated that immediate implant loading or immediate implant restoration can be defined as an occlusal or non-occlusal restoration of implants the same day the implants are placed (Aparicio et al. 2003) or within the first 48 h following implant surgery (Cochran et al. 2004). When focusing on marginal soft-tissue stability, the prosthetic reconstruction may have an important effect on marginal soft-tissue guidance during initial wound healing. Therefore, only studies where the restorations were placed the same day or at least within 24 h were included in the present systematic review.

Clinical parameters for evaluating the peri-implant marginal soft tissue

Peri-implant marginal soft tissues can be assessed with regard to 'periodontal' or morphologic and esthetic aspects. Clinical parameters used in different studies for evaluating periodontal aspects mainly include plaque and bleeding indices, probing depth (PD) measurements and bleeding upon probing. Morphologic alterations are mainly evaluated using metrical measurements of marginal or interproximal tissue levels. Furthermore, for esthetic evaluations the interproximal soft tissue fill most frequently is classified using Jemt's papilla index (Jemt 1997).

Study selection

The review was restricted to peer-reviewed publications dealing with endosseous, solid titanium implants. Only data from human studies and with a minimum follow-up period of 12 months were evaluated. If articles reported on case series, at least five consecutive cases had to be included. Reports on immediate post-operative adverse events on soft-tissue level such as swelling, edema, sensory disturbances, etc., were not included in this review. Furthermore, studies on temporary implants (mini-implants) and on retrieved implants for histological evaluations were excluded.

Regarding the study design, clinical trials including randomized trials, controlled trials, prospective and retrospective cohort studies and prospective and retrospective cases series were considered for inclusion in the present review. Finally, the studies must reflect clinical examinations of the implant-borne reconstruction and related marginal tissues. Publications based on patient's records, questionnaires or interviews were excluded.

Search strategy

A Medline search was conducted, and articles published in the English language from 1966 up to August 2005 were screened. The following search terms and key words were used and limited to human trials: 'dental/oral implants' and 'immediate loading,' 'dental/oral implants' and 'immediate occlusal loading,' 'dental/oral implants' and 'immediate restoration,' 'dental/oral implants' and 'immediate provisionalization,' 'dental/oral implants' and 'survival,' 'dental/oral implants' and 'survival rate', 'dental/oral implants' and 'survival analysis', 'dental/oral implants' and 'cohort studies,' 'dental/oral implants' and 'case control studies,' 'dental/oral implants' and 'controlled clinical trials,' 'dental/oral implants' and 'randomized controlled clinical trials,' 'dental/oral implants' and 'complications,' 'dental/oral implants' and 'longitudinal,' 'dental/oral implants' and 'prospective,' 'dental/oral implants' and 'retrospective.'

To expand this, additional electronic search strategies included the terms 'marginal bone level,' 'marginal tissue reaction,' 'marginal remodeling,' 'marginal recession,' 'soft-tissue recession,' 'failure,' 'peri-implantitis,' 'peri-implant mucositis,' 'complication,' and 'biological complication.'

Subsequently, hand searches were performed and included (1) bibliographies of previous reviews on the topic of immediate implant loading, (2) bibliographies of all publications considered in this review, and (3) the following peer-reviewed journals: *Clinical Implant Dentistry and Related Research*, *Clinical Oral Implants Research*, *International Journal of Oral & Maxillofacial Implants*, *International Journal of Periodontics & Restorative Dentistry*, *Journal of Clinical Periodontology*, *Journal of Periodontology*, *Journal of Prosthetic Dentistry*, *Journal of Oral Rehabilitation*, *European Journal of Oral Sciences*, *Journal of Dental Research*, *International Journal of Prosthodontics*, *British Journal of Oral and Maxillofacial Surgery*, *Swedish Dental Journal*, *International Dental Journal*, *American Journal of Dentistry*, *Quintessence International*, *Australian Dental Journal*, *Journal of Oral Implantology*.

Validity assessment

Titles and abstracts received from the electronic search were independently screened by two examiners (R. G. and A. Z.). The full text was obtained of all papers that were considered suitable for inclusion by one or both of the reviewers. Subsequently, full text of all selected papers was assessed independently by both reviewers against the stated inclusion criteria. Disagree-

ments were solved by discussion among the reviewers. Finally, data was independently extracted by the two reviewers and recorded in a data extraction sheet.

Results

The electronic search provided 167 articles, of which 161 were selected for full-text analysis. Hand search resulted in additional 79 papers that were reviewed by both examiners. Finally, a total of 17 studies could be identified fulfilling the inclusion criteria (Table 1). Of these, five reported on implants supporting bar-retained overdentures in the mandible and 16 on implants supporting fixed single-tooth or partial reconstructions. Furthermore, two of the included studies were randomized-controlled trials (RCTs), four were controlled clinical trials, and 11 were classified as prospective case series. Interestingly, none of the included studies was published before 2000 and no multi-center studies were available. Seven studies reported on a 1-year data, and the longest follow-up within the included studies was 4 years. The total number of patients treated within the 17 studies was 432 including a total 706 implants studied. In six studies, implants were placed and restored immediately after tooth extraction, whereas implants followed in the remaining 11 studies were placed in healed sites. Seven implant systems had been applied in patient treatment in these studies: Ankylos System (Friadent, Mannheim, Germany), Astra (Astra Tech, Mölndal, Sweden), Brånemark System (Nobel Biocare, Gothenburg, Sweden), ITI dental implant system (Straumann, Basel, Switzerland), Replace System (Nobel Biocare, Gothenburg, Sweden), Spline (Zimmer Dental, Carlsbad, CA, USA), Steri-Oss (Nobel Biocare, Gothenburg, Sweden).

Overall, the articles reported on many different procedures: single-tooth vs. partial-arch vs. full-arch rehabilitation; fixed vs. removable restorations, implants placed into immediate extraction sites vs. healed sites; implants placed using conventional flap surgery vs. flapless surgery, screw-retained vs. cemented restorations, etc. Moreover, follow-up times and time points varied considerably between the different articles. Therefore, a meta-analysis was not performed. Data was further subdivided into the (1) periodontal measurements, and (2) morphologic and esthetic assessments (Table 2).

Soft-tissue evaluations conducted at bar-retained overdentures

Chiapasco et al. (2001) published in 2001 a randomized-controlled clinical trial on immediately and conventionally loaded implants supporting bar-retained overdentures in mandibles. Twenty patients with edentulous lower jaws were randomly assigned to two groups: (1) immediately connecting abutments during surgery followed by a bar and overdenture and (2) conventional loading following a standard protocol for submerged implants with a 4–8 months healing period until loading. Both groups were followed for 2 years. Cumulative success rate reported according to the criteria defined by Albrektsson et al. (1986) was 97.5% for both groups, with one implant lost shortly after initiation of loading in each group. At 6, 12 and 24 months after prosthetic loading, PD was evaluated and modified plaque (mPI) and bleeding (mBI) indices were recorded according to the modifications described by Mombelli & Lang (1994). No significant differences were found with regard to medians and ranges of mPI, mBI and PD at any time point of evaluation.

More recently, Romeo et al. (2002) published a prospective comparative study on immediate vs. delayed loading of implant-supported bar-retained overdentures in the lower jaw using a protocol identical to that described by Chiapasco et al. (2001). In total, 20 patients with edentulous mandibles were randomly assigned to the two groups. The follow-up period was on average 2 years and the cumulative success rates were 100% for the test and 97.5% for the control group. In the control group, one implant was lost 1 year after loading because of peri-implantitis. The peri-implant soft tissues were evaluated during the course of the study using mPI, mBI and PD measurements. After 2 years, no statistically significant differences between the two groups were found. The authors concluded that peri-implant soft-tissue parameters at implants placed in the interforaminal region of the edentulous mandible and immediately loaded with a bar-retained overdenture were consistent with those reported when using a traditional, delayed loading protocol (Lekholm et al. 1986; Leimola-Virtanen et al. 1995).

Within a randomized-controlled clinical trial Gatti & Chiapasco (2002) documented the peri-implant soft-tissue reaction at conventional two-piece implants (control group) and at one-piece implants (test group). In each group, five patients received four test or control implants in the interforaminal region of the edentulous mandible. Subsequently, a u-shaped bar was connected to the implants within the next 24 h and the implants immediately loaded with an overdenture. The peri-implant soft tissues were evaluated at 12 and 24 months following surgery using mPI, mBI (Mombelli & Lang 1994) and PD. No significant differences were found between the two groups with regard to mPI, mBI and PD, and the results were consistent with those reported when using a staged loading protocol (Naert et al. 1988; Mericske-Stern et al. 1994; Boerrigter et al. 1997; Nishimura et al. 1997). The authors concluded that for immediate loading the presence of a micro-gap between the implant and the abutment in two-piece implant systems seems not to be a critical factor as far as peri-implant soft-tissue health is concerned. However, this conclusion is based on a very small sample size (five cases).

Rungcharassaeng et al. (2002) published a case series of five patients with edentulous mandibles where they connected within the first 24 h after surgery a bar on four implants placed in the interforaminal region. During the 1-year follow-up, peri-implant soft tissues were evaluated using an mPI (Mombelli & Lang 1994), PD measurements and bleeding on probing. Significant decreases in mean PD and plaque index were noted during the course of the study, but no significant differences in frequency of bleeding upon probing. The decrease in mean plaque index with time indicated that, in general, the patients' oral hygiene improved. The very low frequency of bleeding upon probing and the mean PD < 3 mm indicated the presence of healthy peri-implant tissue (Mombelli et al. 1987). Within the limitations of this small sample size the authors concluded that the peri-implant soft-tissue response at immediately loaded, HA-coated implants was favorable and comparable with

Table 1. **Characteristics of studies included**

Study	Indication	Type of study	No. of patients	No. of implants	Implant system	Time to loading/ restoration	Bone grafting procedures	Follow-up period mean (range)	CSR survival or success rate %
Abboud et al. (2005)	ST	P	20	20	Ankylos system	At placement	0	12 m	95
Cannizzaro & Leone (2003)	ST and sFPD	PC test	14	46	Spline	Same day	0	24 m	100
		Control	14	46		Following 3.5–4.5 months	0	24 m (loading)	97.8
Chiapasco et al. (2001)	OD	RCT test	10	40	Brånemark system	Standard abutments immediately, u-shaped bar within 2–3 days	0	24 m	97.5
		Control	10	40		Following 4–8 months of submerged healing	0	24 m (loading)	97.5
Cornelini et al. (2004)	ST	P	30	30	ITI standard	Within 24 h	0	12 m	96.7
Cornelini et al. (2005)	ST	P	22	22	ITI, TE	Within 24 h	Only BioGide coverage (when bone defects >2 mm)	12 m	100
Ericsson et al. (2000)	ST	PC test	14	14	Brånemark system	Within 24 h	0	18 m	85.8
		Control	8	8		2-stage according standard protocol	0	18 m	100
Gatti & Chiapasco (2002)	OD	RCT test	5	20	Brånemark system	Within 24 h	0	24 m	100
		Control	5	20		Within 24 h	0	24 m	100
Glauser et al. (2005)	ST and sFPD	P	38	102	Brånemark system	At placement	Allowed (64 sites $\gg$ autogenous bone + BioOss + BioGide)	49 m (42–58)	97.1
Groisman et al. (2003)	ST	P	92	92	Replace	At placement	Autogenous graft when gap implant-to-bone wall >1 mm	6–24 m results at 24 m?	93.5
Kan et al. (2003)	ST	P	35	35	Replace	At placement	0	12 m (12–42)	100
Kan & Rungcharassaeng (2003)	ST(multiple/ adjacent)	P	6	14	Replace	At placement	0	22.6 m (12–34)	100
Norton (2004)	ST	P	25	28	Astra Tech	At placement	0	20.3 m (13–30)	96.4
Proussaefs & Lozada (2004)	ST	P	10	10	Replace	At placement	0	36 m	100
Romeo et al. (2002)	OD	PC test	10	20	ITI standard	Octa abutments immediately, bar manipulated after 1 day, overdenture after 2 days	–	24 m	100
		Control	10	20		Octa abutments immediately, overdenture after 3–4 m			97.5
Rungcharassaeng et al. (2002)	OD	P	5	20	Steri-Oss	Implant splinted within 24 h final prosthesis with EDS clips 1–2 weeks thereafter	0	12 m	100
Ryser et al. (2005)	ST	PC control	25	25	Steri-Oss	Delayed (not specified)	0	24 m	Not reported
		Test	16	16	Spline	At placement	0	12 m	Not reported
Stricker et al. (2004)	OD	P	10	20	ITI, SLA	Bar after 1 day, OD after 7 days	–	24 m	100

Type of study: P, prospective; PC, prospective controlled; RCT, randomized controlled trial indication: ST, single-tooth restorations; sFPD, short-span fixed partial dentures; OD, mandibular bar-retained overdentures; m, month.

Table 2a. **Summary of parameters evaluated in included studies on fixed reconstructions**

Study	Type of study	Indication	# patients	Patient mean age (range)	# implant	Surgery	Time of implant placement	Time of FU	Mean FU time	FU sequence FU with soft tissue evaluation	Summary on soft tissue reaction/ complication	Periodontal measurements			Morphologic and esthetic assessments		
												Gingivitis/peri-implant mucositis BOP/bleeding index	Plaque accumulation	Probing depth PD/probing attachment level (PAL)	Summary on esthetic outcome	Facial recession	Papilla evaluation
Abboud et al. (2005)	P	ST	20	33 (21–60)	20	FF	H	1 year	–	0, 3, 6, 12 m 2, 3, 4, 6, 12 m after def. crown	1 peri-implantitis caused by temporary cement	–	Low (indexing not specified)	–	Natural esthetic outcome	–	Qualitatively reported = gain in 16 patients after 1 y
Cannizzaro & Leone (2003)	PC	ST and sFPD	28 14 test	37.1	92 46 test	FF	H		24 m	1, 6, 12, 18, 24 m	In 6% of all sites some post-op swelling and 5% developed dehiscence of sutures; but in all cases appropriate tissue healing	GI Silness&Loe during entire follow-up period 60% with GI score = 0	PI Silness&Loe during entire follow-up period ϕ 69% with PI score = 0	All implants PD ≤ 2 mm at 24 m	–	–	–
			14 control	38.6	46 control	FF	H		24 m (loading)	1, 6, 12, 18, 24 m		During entire follow-up period 67% with GI score = 0	During entire follow-up period ø 69% with PI score = 0	All implants PD ≤ 2 mm at 24 m			
Cornelini et al. (2004)	P	ST	30	47.5 (27–59)	30	FF	H	12 m	–	0, 6, 12 m 0, 6, 12 m	–	mBI (Mombelli) mBI 35.5% at 12 m	mPI (Mombelli) mPI 32.8% at 12 m	Mean PD 1.6 ± 0.8 at 12 m	All patients reported that provisionals were esthetically acceptable	–	–
Cornelini et al. (2005)	P	ST	22	39 (/)	22	FF	E	12 m	–	0, 12 m 0, 12 m	From an esthetic point of view the stability of the soft tissues made this treatment predictable	Mucositis score 0, no color or texture alterations; 1, slight change in color and texture; 2, marked change in color and texture plus bleeding following superf. probing no mucositis observed at 12 m (≫no score of 2 at 12 m)	Plaque score = presence or absence of visible plaque 13% of all surfaces with plaque at 12 m	Mean PAL at 12 m 0.79 mm prox. 0.45 mm bucc 0.54 mm ling.	From an esthetic point of view the stability of the soft tissues made this treatment predictable	Mean recession of 0.75 mm relative to neighboring teeth at 12 m	61 % Jemt score 2 39% Jemt score 3 no scores of 0, 1 or 4
Ericsson et al. (2000)	PC	ST	14 test	33 (21–56)	14	FF	H	18 m	–	0, 1, 3, 6, 12, 18 m		Angulate bleeding index (van der Weijden et al. 1994) mucositis at 2 implant sites = 16.7%	(+) = present or (−) = absent plaque accumulation at 3 implant sites = 25%	–	All patients reported their crowns to be fully satisfying	–	–
			8 control	–	8	FF	H	18 m	–	6, 12, 18 m postloading		Mucositis at 2 implant sites = 25%	Plaque accumulation at 2 implant sites = 25%	–	All patients reported their crowns to be fully satisfying	–	–
Glauser et al. (2005)	P	ST and sFPD	38	51 (19–77)	102	FF	H (79) and E (23)	4 years	49 m (42–58)	1, 2, 3, 6, 12, 24, 36, 48 m 1, 2,3, 6, 12, 24, 36, 48 m	3 implants removed because of early flap dehiscence with suppuration in GBR area	mBI (Mombelli) 6 m = 25.5% 1 y = 44% 2 y = 30% 3 y = 22.5% 4 y = 31%	6 m = 30.5% 1 y = 42% 2 y = 26.5% 3 y = 19% 4 y = 13%	–	–	–	Mean Jemt index score at mesial papillae 1.4 ± 1.1 at baseline and 2 ± 0.8 at 4 years mean Jemt index score at mesial papillae 1 ± 1.1 at baseline and 1.7 ± 0.8 at 4 years

Groisman et al. (2003)	P	ST	92	–	92	FL	E	6–24 months results at 24 m?	–	1–6 m, afterwards not specified	At 3 implants soft tissue recession at buccal margin >2 mm reference line not specified	–	–	–	Maintenance of mucosal architecture adjacent to immediate implants facilitated	Soft-tissue recession at buccal margin >2 mm at 3 implants reference line not specified	82 implants Jemt index = 3 2 implants Jemt index = 1–2 2 implants Jemt index 0 or 4
Kan et al. (2003)	P	ST	35	36.5 (18–65)	35	FL	E	1 year	16.7 m (12–42)	0, 3, 6, 12 m	Although gingival level changes were statistically significant, they were well within the clinical expectations	–	mPI (Mombelli) baseline score 0=68%, score 1=32% 6 m score 0=80%, score 1=20% 12 m score 0=74%, score 1=26%	–	Although gingival level changes were statistically significant, they were well within the clinical expectations at 12-month follow-up: all patients were satisfied with the esthetic outcome and none had noticed the change in gingival level	Change in gingival level midfacially, reference line to the 2 adjacent teeth baseline, 12 m = −0.55 ± 0.53 mm	Change in papilla level > reference line according to level of papillae before tooth extraction (slides before extraction at 0, 3, 6 and 12 m) baseline-12 m = mesial −0.53 ± 0.39 mm baseline-12 m = distal −0.39 ± 0.40 mm
Kan & Rungcharassaeng (2003)	P	ST (multiple/6 adjacent)		38.5 (27–53)	14	FL	E	12–34 months	22.6 m (12–34 m)	0, 3, 6, 9, 12, 18, 24, 30, 34	All 8 interimplant papillae had been maintained less than 1 mm of facial recession for all implant sites	–	–	–	A highly satisfactory esthetic outcome and papilla index score of 3 was observed in all patients	Base line-24 months: <1 mm facial gingival recession at all implants (using photographs and study casts)	Jemt rating at baseline and at 6 months following final crown placement = at 24 months all 8 interimplant papillae maintained mean Jemt of 3 after mean follow-up time of 22.6 m (pretreatment mean Jemt score 2.75)
Norton (2004)	P	ST	25	48.2 (27–72)	28	FF or FL	H (12) and E (16)	13–30 months	20.3 months	1–12 m	1 out of 24 implants (=4.2%) with unfavorable facial recession of the gingival margin (due to deep implant placement and unfavorable inclination) > poor esthetic outcome	–	–	–	Most implants maintained an esthetic gingival architecture	One recession around one implant and juxtaposing teeth (deep implant placement and unfavorable implant/crown inclination, therefore unacceptable amount of pressure on the labial soft tissues)	–
Proussaefs & Lozada (2004)	P	ST	10	57.1 (37–77)	10	FF	H	3 years	–	0, 1, 3, 6, 12, 36 m	No clinical complications encountered	mBI (Mombelli) 3 m 0.46 ± 0.36 6 m 0.35 ± 0.32 12 m 0.45 ± 0.42 36 m 0.1 ± 0.18	–	Without crown–but straight healing abut-ment ≫ mean PD 3 m 3.6 ± 1.02 mm 6 m 3.2 ± 0.57 mm 12 m 3.2 ± 0.45 mm 36 m 4.3 ± 0.75 mm		Distance from implant platform to gingival crest 3 m 2.8 ± 0.93 mm 6 m 2.4 ± 0.73 mm 12 m 2.4 ± 0.46 mm 36 m 3.1 ± 0.84 mm	–
Ryser et al. (2005)	PC	ST	25 control	(21–65)	25	FF, sub-mergedH healing		12, 24 m	–	12, 24 m	No statistically significant difference between papilla scoring between delayed and immediate provisionalization group	–	–	– –	–		Modified Jemt Index ≫ no statistically signifiacant difference between papilla scoring between delayed and immediate provisionalization group
			16 test		16	FF	H	12 m	–	12 m							

Type of study: P, prospective; PC, prospective controlled; RCT, randomized controlled trial.
Indication: ST, single-tooth restorations; sFPD, short-span fixed partial dentures.
Time of implant placement: H, healed sites; E, extraction sites.
FF, full-thickness flap; FL, flapless surgery; FU, follow-up; m, month; y, year.

***Table 2b*. Summary of parameters evaluated in included studies on mandibular bar-retained overdentures**

Author(s)	Type of study	Indication	# patient	Patient mean age (range)	# implant	Surgery	Time of implant placement	Time of FU	Mean FU time	FU sequence FU with soft tissue evaluation	Summary of soft tissue reaction/ complication	Periodontal measurements		
												Gingivitis/peri-implant mucositis BOP/ bleeding index	Plaque accumulation	Probing depth PD/probing attachment level (PAL)
Chiapasco et al. (2001)	RCT	OD	20 10 test	58.4 (44–73) 59.3 (50–73)	80 40	FF	H	24 m	–	6, 12, 24 m	1 peri-implant infection which responded not to local measurements >1 implant lost	mBI (Mombelli) median 0 at 6/12/24 m	mPI (Mombelli) median 0 to 0.8 at 6/12/24 m	median PD 2 to 2.8 mm at 6/12/24 m
			10 control	57.6 (44–66)	40	FF	H	24 m (loading)	–	6, 12, 24 m (after loading)	–	median 0 at 6/12/24 m	median 0 to 1 at 6/12/24 m	median PD 2 to 3 mm at 6/12/24 m
Gatti & Chiapasco (2002)	RCT	OD	5 test	60.9 (52–81)	20	FF	H	24 m	–	1, 3, 6, 12, 24 m 12, 24 m	No clinical complications encountered	mBI (Mombelli) 12 m: mean 0.3–0.4; 24 m: mean 0.3–0.6	mPI (Mombelli) 12 m: mean 0.5–0.7; 24 m: mean 0.4–1	12 m: mean 2.3–2.9; 24 m: mean 2.5–2.9
			5 control		20	FF	H	24 m	–	12, 24 m	No clinical complications encountered	12 m: mean 0.1–0.5; 24 m: mean 0.3–0.6	12 m: mean 0.4–0.7; 24 m: mean 0.6–0.8	12 m: mean 3–3.4; 24 m: mean 3.1–3.4
Romeo et al. (2002)	PC	OD	20 10 test (immediate loading)	63.2 (42–73)	40 20	FF	H	2 years	–	3, 6, 12, 24 m postloading	No significant difference with regard to mPI, mBI, PD between test and control at 3, 6, 12, 24 m	mBI (Mombelli) 3 m 0.56 ± 0.43 6 m 0.49 ± 0.40 12 m 0.53 ± 0.34 24 m 0.13 ± 0.15	mPI (Mombelli) 3 m 0.99 ± 0.56 6 m 0.74 ± 0.47 12 m 0.78 ± 0.58 24 m 0.61 ± 0.48	probing depth 3 m 2.11 ± 0.63 mm 6 m 2.19 ± 0.55 mm 12 m 2.51 ± 0.46 mm 24 m 2.33 ± 0.28 mm
			10 control (transmucosal healing and delayed loading)		20					3, 6, 12, 24 m postloading		3 m 0.56 ± 0.64 6 m 0.49 ± 0.53 12 m 0.530.50 24 m 0.16 ± 0.36	3 m 0.99 ± 0.74 6 m 0.74 ± 0.63 12 m 0.57 ± 0.68 24 m 0.51 ± 0.74	3 m 2.1 ± 0.79 mm 6 m 2.18 ± 0.68 mm 12 m 2.51 ± 0.59 mm 24 m 2.28 ± 0.63 mm
Rungcharassaeng et al. (2002)	P	OD	5	61 (49–77)	20	–	H	1 year	–	1, 3, 6, 12 m	–	BOP ≫ no signifcant differences in the frequency of bleeding at any time point 1 m 7.5% 3 m 6.25% 6 m 10% 12 m 5%	mPI (Mombelli) ≫ significant decrease with time 1 m mean 1.19 ± 0.75 3 m 1.10 ± 0.82 6 m mean 0.73 ± 1.20 12 m mean 0.49 ± 0.90 > no correlation between plaque and probing depth	PD in mm ≫ significant decrease in mean PD between 1 to 3 months, but stable thereafter 1 m mean 2.43 ± 0.57 mm 3 m mean 1.98 ± 0.64 mm 6 m mean 2.01 ± 0.63 mm 12 m mean 1.96 ± 0.72 mm
Stricker et al. (2004)	P	OD	10	66 y (48–74)	20	FF	H	2 years	29.8 m (24–36)	1, 4, 6, 8, 10, 12, 16 w; 5, 6, 9, 12, 15, 18, 21, 24 m	–	BI (Muehlemann and Son) 1 y score 0 in 92%, score 1 in 8% 1 y score 0 in 92%, score 1 in 8%	–	–

Type of study: P, prospective; PC, prospective controlled; RCT, randomized controlled trial.
Indication: OD, mandibular bar-retained overdentures.
Time of implant placement: H, healed sites.
FF, full-thickness flap; FU, follow-up; m, month; y, year; w, week.

that of conventional, delayed loaded implants after 1 year.

More recently, Stricker et al. (2004) reported on 10 patients receiving two interforaminal implants and a bar-retained overdenture in the edentulous mandible. No implant was lost during the 2-year follow-up and after 1 year, eight patients rated their overall satisfaction as 10 on a VAS. With regard to peri-implant soft-tissue reaction, at 1 and 2 years 92% of all sites exhibited a bleeding index of 0, suggesting healthy peri-implant soft-tissue conditions.

In conclusion on bar-retained mandibular overdentures, only two RCTs indications have been identified where marginal soft-tissue changes have been evaluated comparing immediate loading with the standard protocol (late loading approach). Therefore, the evidence is on a weak level. However, using PD as an outcome measurement for bar-retained mandibular overdentures and referring to the available two RCTs, no differences in probing pocket depth between immediate and late loading could be detected.

Soft-tissue evaluations conducted at partial-fixed reconstructions

Preserving or creating stable as well as harmonious peri-implant soft-tissue contours at fixed reconstructions is of a higher interest as compared with demands related to removable solutions. In the esthetic zone, favorable tissue contours are of paramount importance. In a well-documented study, Kan et al. (2003) followed 35 immediately restored tapered implants placed into extraction sockets in the anterior maxilla. After 1 year, mean mucosal marginal recession was 0.55 ± 0.53 mm midfacially, and 0.53 ± 0.39 and 0.39 ± 0.4 mm at mesial and distal papilla, respectively. The change in marginal tissue level was similar to those reported by Bengazi et al. (1996) for implants within a conventional loading protocol, and slightly less than those published by Small & Tarnow (2000). Furthermore, evaluating the esthetic outcome using a rating from 1 (poor) to 10 (excellent) the authors reported an average patient satisfaction of 9.9.

In a further study on immediate implant restoration, Kan & Rungcharassaeng (2003) reported on the esthetic outcome in a group of six consecutive patients where they had performed multiple single-tooth replacements in the anterior maxilla using an alternating immediate implant placement and provisionalization. Preoperatively as well as at the 24 months follow-up, facial gingival levels at implant sites were measured and interimplant papillae assessed using Jemt's papilla index. All eight interimplant papillae had been maintained with a mean index score of three, compared with a mean pretreatment score of 2.75. This improvement was explained by the fact that an interproximal papilla deficit may have been compensated prosthetically by increasing the emergence profiles at the adjacent restorations and/or moving the cervical contact point apically. Additionally, for all 14 implants less than 1 mm of facial mucosal recession was noted between baseline and follow-up. Furthermore, all patients were satisfied with the final esthetic outcome (mean rating of 9.8 on VAS from 0 (worst) to 10), and none reported any noticeable changes in the gingival levels or architecture. Based on the maintenance of the mucosal architecture, the authors concluded that when confronted with extractions of multiple adjacent teeth the proposed technique using alternating tooth replacements does not compromise the stability of the interproximal papillae. On the other hand, it was stated that even with careful execution, facial and/or interproximal gingival recession may still occur after immediate implant placement and provisionalization procedures, especially with a thin, scalloped periodontium. Overall, the described procedure is technique-sensitive and requires additional studies and long-term follow-up to substantiate its viability.

In a prospective clinical study, Ericsson et al. (2000) reported on a group of 14 immediately restored single-tooth implants and compared the findings with a control group of eight implants with a staged, traditional protocol. Despite the loss of two fixtures in the experimental group, no or minimal differences with regard to plaque accumulation and peri-implant mucositis was noted between the test and control implants. Presence of plaque at 18-month evaluation was detected at 25% of all sites in both groups. Furthermore, all patients in both groups reported their crowns to be esthetically fully satisfying.

In a controlled clinical trial by Cannizzaro & Leone (2003) compared immediate loading with delayed loading. In each group, 14 patients receiving partial reconstructions (single crowns and short-span FPDs) were followed over 2 years. No substantial differences were noted between test and control implants with regard to gingival and plaque indices or PD. In particular, a gingival index score of 0 according to Löce & Silness (1967) was found on average during the entire follow-up period at 60.7% of all test and at 67.7% of all control implants. A plaque index score of 0 was reported for 69.1% at test and 69.7% at control implants during the 24 months follow-up period. For all implants in both groups, pocket PD was found to be 2 mm or less at any follow-up time point.

In a prospective study by Cornelini et al. (2004), 30 single-tooth implants immediately restored in mandibular molar sites were followed for 12 months. One implant was removed 4 weeks after placement due to an acute infection at the implant site, resulting in a cumulative survival rate of 96.7% after 12 months of follow-up. With regard to morphological alterations, no change in mean width of keratinized mucosa, as measured midbuccally at each implant, was encountered (3.1 ± 0.5 mm at baseline and 6-month follow-up). At the 12-month evaluation, plaque was observed at 32.8% of the sites examined. As a consequence, a slight bleeding tendency upon light probing was reported for 35.5% of all sites evaluated. Furthermore, PD measurements were in a range from 0.2 to 2.7 mm (mean 1.6 ± 0.8 mm) for all implant sites.

In a further prospective study, Cornelini et al. (2005) evaluated 22 single-tooth implants that were placed into fresh extraction sockets and had been restored within 24 h. Mean variation in facial marginal mucosal level over the 12-month follow-up period, as compared with the neighbouring teeth, was -0.75 mm. Regarding variation of papilla position according to Jemt's index, no scores of 0, 1 or 4 were found at 12 months. In detail, 27 papillae (61%) presented with a score of 2 and 17 (39%) were rated as 3. Moreover, at the 12-month examination the frequency of plaque-carrying surfaces at implant sites was 13%, and no peri-implant mucositis (no score of two) was reported. From an

esthetic point of view, approximately 0.6–1 mm of facial marginal recession can be expected at 1 year when selecting a staged loading protocol (Gelb 1993; Bengazi et al. 1996; Grunder 2002). Moreover, this marginal tissue recession presumably occurs during the first 3 months post-surgery (Small & Tarnow 2000). Hence, the data presented by Cornelini et al. (2005) are similar in terms of marginal changes.

In a publication by Groisman et al. (2003), 2-year results on single-tooth implants placed immediately following extraction of maxillary incisors were presented. A total of 92 implants were inserted using flapless surgery and immediate provisionalization in order to properly support the supra-crestal soft tisssue. Finally, 86 implants were classified as successful. Recession of labial soft-tissue margins of more than 2 mm was reported for three implants. Furthermore, classifying interproximal soft-tissue fill using Jemt's index, 82 implants completely preserved the shape of the papilla (score 3), whereas the remaining four implants exhibited some alterations in shape (score 1, 2, or 4).

Norton (2004) published a prospective case series on 28 maxillary single-tooth implants immediately restored and followed on average for 20.3 months. One implant was lost during the first month following surgery, and for an additional implant an unfavorable facial soft-tissue recessions due to deep implant placement and unfavorable inclination was reported. Overall, the author stated that most implants maintained an esthetic gingival architecture and that it appeared that the proposed procedure could result in favorable soft-tissue outcome.

Proussaefs & Lozada (2004) published data on 10 consecutive patients having received one implant each in a healed maxillary premolar localization. All 10 implants healed uneventful and peri-implant soft-tissue parameters were evaluated at 3, 6, 12 and 36 months. It was concluded that the findings with regard to bleeding on probing and PD are in agreement with findings of previous retrospective studies on two-stage loading protocols (Quirynen et al. 1992; Nishimura et al. 1997). Despite the favorable outcome in terms of implant success and tissue stability, the authors concluded that a larger sample size and longer follow-ups are needed before definitive conclusions on the predictability of this concept can be drawn.

Glauser et al. (2005) followed 102 implants subjected to immediate occlusal loading in 38 patients. Of these, 20 supported single crowns, and 82 FPDs. After 4 years, a cumulative success rate of 97.1% was reported. At the 4-year examination, presence of marginal plaque and of bleeding on probing was noted for 13% and 31% of all sites, thereby remaining unchanged since the 1-year follow-up. These data are well in line with 1-year results reported by Cornelini et al. (2005), but slightly lower, than 1–2-year data presented by Cannizzaro & Leone (2003), Kan et al. (2003) and Cornelini et al. (2004). Furthermore, to evaluate changes in interproximal tissue height the authors used during the 4-year follow-up period the papilla index score introduced by Jemt (1997). The general finding was that the papillae re-established continuously during the first 2 years, after which they remained stable. This indicated that the maturation and formation of the interproximal soft tissues occurred during a rather long period of time and that a papilla actually was formed even though it did not reach the optimal shape in all cases. This development of papillae over time corresponds well to findings reported earlier when using a staged protocol (Jemt 1999; Jemt & Lekholm 2003). In these studies, single-tooth restorations were placed following a two-stage technique and evaluated during a 2-year period after implant restoration. Overall, a slightly higher mean papilla index score was reported in these studies, both preoperatively and at the 2-year follow-up, as compared with the data from Glauser and colleagues. This is probably due to the circumstance that in the studies performed by Jemt only single-tooth restorations were evaluated while in the latter study the majority were partial restorations. It is obvious that papillae facing an implant on both sides start and end at a lower score as compared with those facing a tooth on one side. Moreover, the fact that immediate implant restoration was applied in the aforementioned study did not seem to influence the development of the papillae. In particular, the mean index score values reported by Jemt (2.6 $\pm$ 0.6 mesially, 2.1 $\pm$ 0.6 distally) when using the two-stage technique (Jemt 1999) correspond well to the mean index score values found in the Glauser study for papillae facing a tooth (2.5 $\pm$ 0.6 mesially, 2.1 $\pm$ 0.8 distally).

In a prospective case series conducted by Abboud et al. (2005), 20 patients received in maxillary or mandibular molar and premolar sites single-tooth implants. All 20 implants were placed in healed sites and restored the same day. Because of occurrence of provisional cement impaction while placing the first seven temporary crowns, the following 13 crowns were screwed onto the implants. After 6 weeks of healing temporary restorations were replaced by definitive crowns. The authors summarized that during the first 12 months of follow-up plaque accumulation at abutments was low. Furthermore, it was stated that the immediate provisionalization process established an esthetic and stable mucosal profile with gain in interproximal papilla height at 16 implants after 1 year. However, no detailed measurements were presented. Moreover, one implant failure and one incident of peri-implantitis were reported. The authors concluded that these adverse events were caused by temporary cement retained on the implant surface.

Ryser et al. (2005) evaluated the correlation between papilla and crestal bone levels around single-tooth implants in a prospective study. Bone level measurements and papilla scoring performed at baseline and at 1 year following crown insertion in a group of 16 immediately restored implants showed no statistically significant difference as compared with data gathered from a control group including 25 implants receiving crowns in a delayed approach. Unfortunately, papilla scores at baseline and at the 1-year follow-up were not listed for each group. Nevertheless, the authors concluded that there were significant relationships between the vertical distances from restorative contact point to bone levels, with the distance from the contact point to the bone level at the adjacent tooth being the most critical to papilla maintenance. Furthermore, they reported no significant relationships between horizontal distance and papilla maintenance.

In conclusion on single-tooth or partial fixed reconstructions, no RCTs could be identified comparing immediate loading or

restoration with the standard protocol (late loading approach). Therefore, the evidence regarding soft-tissue aspects is on a weak level. However, using gingival inflammation as an outcome measurement for soft-tissue health, immediate loading or restoration protocols have rendered similar results as reported for the standard protocol. When the esthetic outcome has been assessed using the Jemt index, five studies on fixed reconstructions are available (one prospective controlled and four prospective case series). The results after 1 year demonstrate considerable heterogeneity ranging from ideal esthetics (score 3) to unsatisfactory (scores 1–2). Furthermore, facial recession of the mucosal margin has been evaluated in four studies (all prospective case series) showing as average a mean recession between 0.5 and 1 mm after 1 year.

The majority of the studies are reporting on implants placed into healed conditions, whereas only five trials included implants placed into extraction sites. Furthermore, only two studies included multiple, adjacent implants and reported on fixed partial reconstructions.

Discussion

Numerous studies have demonstrated the feasibility and predictability of immediate implant loading or restoration. However, most of these studies report mainly on survival or success rates. Publications on marginal bone reaction are already limited. Moreover, when it comes to the documentation of peri-implant soft-tissue reactions at implants subjected to immediate loading or restoration, only sparse data are available. Furthermore, it must be recognized that, with few exceptions, data published in the selected studies were generated by exceptionally experienced, highly skilled clinicians working under tightly controlled conditions on a relatively small, statistically inconclusive number of implants and patients. Recent reviews observed a paucity of properly designed studies to allow definite conclusions on this treatment modality (Gapski et al. 2003; Chiapasco 2004; Ganeles & Wismeijer 2004). In particular, for soft-tissue aspects at immediately loaded or restored implants this observation is clearly confirmed by the present systematic review.

Several studies included in the present review stated that the peri-implant soft tissues appeared to be comparable with conventional protocols and that implant outcomes were not compromised by immediate loading or restoration (Cornelini et al. 2004; Norton 2004). However, others reported a change in soft-tissue level, describing it as a soft-tissue recession (Groisman et al. 2003; Kan & Rungcharassaeng 2003; Cornelini et al. 2005). This suggests that a period of soft-tissue healing, along with a change, is to be expected following implant surgery and immediate restoration or loading. When selecting a staged approach with late implant loading, approximately 1 mm of facial mucosal recession can be expected between baseline and the 1-year follow-up (Gelb 1993; Bengazi et al. 1996; Small & Tarnow 2000; Grunder 2002). Recently, based on a classic review on immediate implant loading a consensus group stated that with regard to an esthetic soft-tissue outcome at single-tooth restorations, the contours should be ideal at the beginning of the treatment (Misch et al. 2004). As a consequence, the group recommended a traditional staged approach in case of absence of ideal conditions.

With regard to the esthetic outcome, further indices such as Implant Crown Esthetic Index (Meijer et al. 2005) and the Pink Esthetic Score (Fürhauser et al. 2005) have aimed to make a composite esthetic appraisal of the final restorative result. However, these indices do not specifically assess the soft-tissue component using objective metrical measurements.

Conclusions

Studies included in this review indicate that once immediately loaded or restored implants integrate successfully, they appear to show a soft-tissue reaction comparable with those of -conventionally loaded implants. Furthermore, no evidence suggests that deleterious peri-implant mucosal complications can be directly attributed to immediate loading or restoration protocols.

In general, follow-up periods are short, numbers of patients and/or implants are few, and most studies lack of proper documentation with regard to marginal soft-tissue aspects. This signifies the need for further evaluation and documentation. More accurate long-term studies with a stronger study design (i.e., RCT) reporting more detailed on surgical and prosthetic treatment and follow-up protocols are required to allow for proper comparisons and conclusions. When documenting the esthetic outcome related to interproximal soft-tissue reaction, future studies should consider quantitative metrical measurements instead of Jemt's indexing.

References

Abboud, M., Koeck, B., Stark, H., Wahl, G. & Paillon, R. (2005) Immediate loading of single-tooth implants in the posterior region. *International Journal of Oral & Maxillofacial Implants* **20**: 61–68.

Albrektsson, T., Zarb, G.A., Worthington, P. & Eriksson, R.A. (1986) The long-term efficacy of currently used dental implants: a review and proposed criteria of success. *International Journal of Oral & Maxillofacial Implants* **1**: 11–25.

Aparicio, C., Rangert, B. & Sennerby, L. (2003) Immediate/early loading of dental implants: a report from the Sociedad Espanola de Implantes World Congress consensus meeting in Barcelona, Spain, 2002. *Clinical Implant Dentistry & Related Research* **5**: 57–60.

Attard, N.J. & Zarb, G.A. (2005) Immediate and early loading protocols: a literature review of clinical studies. *Journal of Prosthetic Dentistry* **94**: 242–258.

Bengazi, F., Wennström, J.L. & Lekholm, U. (1996) Recession of the soft tissue margin at oral implants. A 2-year longitudinal prospective study. *Clinical Oral Implants Research* **7**: 303–310.

Boerrigter, E.M., Van Oort, R.P., Raghoebar, G.M., Stegenga, B., Schoen, P.J. & Boering, G. (1997) A controlled clinical trial of implant-retained mandibular overdentures. *Journal of Oral Rehabilitation* **24**: 182–190.

Cannizzaro, G. & Leone, M. (2003) Restoration of partially edentulous patients using dental implants with a microtextured surface: a prospective comparison of delayed and immediate full occlusal loading. *International Journal of Oral & Maxillofacial Implants* **18**: 512–522.

Chiapasco, M. (2004) Early and immediate restoration and loading of implants in completely edentulous patients. *International Journal of Oral & Maxillofacial Implants* **19** (Suppl.): 76–91.

Chiapasco, M., Abati, S., Romeo, E. & Vogel, G. (2001) Implant-retained mandibular overdentures

with Brånemark System Mk II implants: a prospective comparative study between delayed and immediate loading. *International Journal of Oral & Maxillofacial Implants* **16**: 537–546.

Chiapasco, M., Gatti, C., Rossi, E., Haefliger, W. & Markwalder, T.H. (1997) Implant-retained mandibular overdentures with immediate loading: a retrospective multicenter study on 226 consecutive cases. *Clinical Oral Implants Research* **8**: 48–57.

Cochran, D.L., Morton, D. & Weber, H.P. (2004) Consensus statements and recommended clinical procedures regarding loading protocols for endosseous dental implants. *International Journal of Oral & Maxillofacial Implants* **19** (Suppl.): 109–113.

Cornelini, R., Cangini, F., Covani, U., Barone, A. & Buser, D. (2004) Immediate restoration of single-tooth implants in mandibular molar sites: a 12-month preliminary report. *International Journal of Oral & Maxillofacial Implants* **19**: 855–860.

Cornelini, R., Cangini, F., Covani, U. & Wilson, T.G. (2005) Immediate restoration of implants placed into fresh extraction sockets for single-tooth replacement: a prospective clinical study. *International Journal of Periodontics and Restorative Dentistry* **25**: 439–447.

Engstrand, P., Gröndahl, K., Ohrnell, L.O., Nilsson, P., Nannmark, U. & Brånemark, P.I. (2003) Prospective follow-up study of 95 patients with edentulous mandibles treated according to the Brånemark Novum concept. *Clinical Implant Dentistry and Related Research* **5**: 3–10.

Ericsson, I., Nilson, H. & Nilner, K. (2001) Immediate functional loading of Brånemark single tooth implants. A 5-year clinical follow-up. *Applied Osseointegration Research* **2**: 12–16.

Ericsson, I., Nilson, H., Lindh, T., Nilner, K. & Randow, K. (2000) Immediate functional loading of Brånemark single tooth implants. An 18 months' clinical pilot follow-up study. *Clinical Oral Implants Research* **11**: 26–33.

Fürhauser, R., Florescu, D., Benesch, T., Haas, R., Mailath, G. & Watzek, G. (2005) Evaluation of soft tissue around single-tooth implant crowns: the pink esthetic score. *Clinical Oral Implants Research* **16**: 639–644.

Ganeles, J. & Wismeijer, D. (2004) Early and immediately restored and loaded dental implants for single-tooth and partial-arch applications. *International Journal of Oral & Maxillofacial Implants* **19** (Suppl.): 92–102.

Gapski, R., Hom-Lay, W., Mascarenhas, P. & Lang, N.P. (2003) Critical review of immediate implant loading. *Clinical Oral Implants Research* **14**: 515–527.

Gatti, C. & Chiapasco, M. (2002) Immediate loading of Brånemark implants: a 24-month follow-up of a comparative prospective pilot study between mandibular overdenture supported by Conical® transmucosal and standard Mk II implants. *Clinical Implant Dentistry & Related Research* **4**: 190–196.

Gelb, D. (1993) Immediate implant surgery: three years retrospective evaluation of 50 consecutive cases. *International Journal of Oral & Maxillofacial Implants* **8**: 388–399.

Glauser, R., Ruhstaller, P., Windisch, S., Zembic, A., Lundgren, A.K., Gottlow, J. & Hämmerle, C.H.F. (2005) Immediate occlusal loading of Brånemark System TiUnite implants placed predominantely in soft bone: 4-year results of a prospective clinical study. *Clinical Implant Dentistry and Related Research* **7** (Suppl.): 52–59.

Groisman, M., Frossard, W.M., Ferreira, H.M., de Menezes Filho, L.M. & Touati, B. (2003) Single-tooth implants in the maxillary incisor region with immediate provisionalization: 2-year prospective study. *Practical Procedures in Aesthetic Dentistry* **15**: 115–122.

Grunder, U. (2002) Stability of the mucosal topography around single-tooth implants and adjacent teeth: 1-year results. *International Journal of Periodontics and Restorative Dentistry* **20**: 11–17.

Jemt, T. (1997) Regeneration of gingival papillae after single-implant treatment. *International Journal of Periodontics and Restorative Dentistry* **17**: 326–333.

Jemt, T. (1999) Restoring the gingival contour by means of provisional resin crowns after single-implant treatment. *International Journal of Periodontics and Restorative Dentistry* **19**: 21–29.

Jemt, T. & Lekholm, U. (2003) Measurements of buccal tissue volumes at single-implant restorations after local bone grafting in maxillas: a 3-year clinical prospective study case series. *Clinical Implant Dentistry & Related Research* **5**: 63–70.

Kan, J.Y.K. & Rungcharassaeng, K. (2003) Interimplant papilla preservation in the esthetic zone: a report of six consecutive cases. *International Journal of Periodontics and Restorative Dentistry* **23**: *249–259.*

Kan, J.Y.K., Rungcharassaeng, K. & Lozada, J.L. (2003) Immediate placement and provisionalization of maxillary anterior single implants: 1-year prospective study. *International Journal of Oral & Maxillofacial Implants* **18**: 31–39.

Leimola-Virtanen, R., Peltola, J., Helenius, H. & Happonen, R.P. (1995) ITI titanium plasma-sprayed screw implants in the treatment of edentulous mandibles: a follow-up study of 39 patients. *International Journal of Oral and Maxillofacial Implants* **10**: 373–378.

Lekholm, U., Adell, R., Lindhe, J., Brånemark, P.I., Eriksson, B., Rockler, B., Lindvall, A.M. & Yoneyama, T. (1986) Marginal tissue reactions at osseointegrated titanium fixtures. (II) A cross-sectional retrospective study. *International Journal of Oral and Maxillofacial Surgery* **15**: 53–61.

Löce, H. & Silness, J. (1967) The ginvival index, the plaque index, and the retention index system. *Journal of Periodontology* **38**: 610–616.

Meijer, H.J.A., Stellingsma, K., Meijndert, L. & Raghoebar, G.M. (2005) A new index for rating aesthetics of implant-supported single crowns and adjacent soft tissues – the Implant Crown Aesthetic Index. *Clinical oral Implants Research* **16**: 645–649.

Mericske-Stern, R., Steinlin Schaffner, T., Marti, P. & Geering, A.H. (1994) Peri-implant mucosal aspects of ITI implants supporting overdentures: a five-year longitudinal study. *Clinical Oral Implants Research* **5**: 9–18.

Misch, C.E., Hahn, J., Judy, K.W., Lemons, J.E., Linkow, L.I., Lozada, J.L., Mills, E., Misch, C.M., Salama, H., Sharawy, M., Testori, T. & Wang, H.-L. (2004) Workshop guidelines on immediate loading in implant dentistry. *Journal of Oral Implantology* **30**: 283–288.

Mombelli, A. & Lang, N.P. (1994) Clinical parameters for the evaluation of dental implants. *Periodontology 2000* **4**: 81–86.

Mombelli, A., van Osten, M.A.C., Schürch, E.J. & Lang, N.P. (1987) The microbiota associated with successful or failing osseointegrated titanium implants. *Oral Microbiology and Immunology* **2**: 145–151.

Morton, D., Jaffin, R.A. & Weber, H.-P. (2004) Immediate restoration and loading of dental implants: clinical considerations and protocols. *International Journal of Oral & Maxillofacial Implants* **19** (Suppl.): 103–108.

Naert, I., De Clercq, M., Theuniers, G. & Schepers, E. (1988) Overdentures supported by osseointegrated fixtures for the edentulous mandible: a 2.5 years report. *International Journal of Oral & Maxillofacial Implants* **3**: 191–196.

Nishimura, K., Itoh, T., Takaki, K., Hosokawa, R., Naito, T. & Yokota, M. (1997) Periodontal parameters of osseointegrated dental implants. A 4-year controlled follow-up study. *Clinical Oral Implants Research* **8**: 272–278.

Norton, M.R. (2004) A short-term clinical evaluation of immediately restored maxillary TiO-blast single-tooth implants. *International Journal of Oral & Maxillofacial Implants* **19**: 274–281.

Proussaefs, P.T. & Lozada, J.L. (2004) Immediate loading of hydroxyapatite-coated implants in the maxillary premolar area: three-year results of a pilot study. *Journal of Prosthetic Dentistry* **91**: 228–233.

Romeo, E., Chiapasco, M., Lazza, A., Casentini, P., Ghisolfi, M., Iorio, M. & Vogel, G. (2002) Implant-retained mandibular overdentures with ITI implants. A comparison of 2-year results between delayed and immediate loading. *Clinical Oral Implants Research* **13**: 495–501.

Rungcharassaeng, K., Lozada, J.L., Kan, J.Y.K., Kim, J.S., Campagni, W.V. & Munoz, C.A. (2002) Peri-implant tissue response of immediately loaded, threaded, HA-coated implants: 1-year results. *Journal of Prosthetic Dentistry* **87**: 173–181.

Ryser, M.R., Block, M.S. & Mercante, D.E. (2005) Correlation of papilla to crestal bone levels around single tooth implants in immediate or delayed crown protocols. *International Journal of Oral and Maxillofacial Surgery* **63**: 1184–1195.

Small, P.N. & Tarnow, D.P. (2000) Gingival recession around implants: a 1-year longitudinal prospective study. *International Journal of Oral & Maxillofacial Implants* **15**: 527–532.

Stricker, A., Gutwald, R., Schmelzeisen, R. & Gellrich, N.G. (2004) Immediate loading of 2 interforaminal dental implants supporting an overdenture: clinical and radiographic results after 24 months. *International Journal of Oral & Maxillofacial Implants* **19**: 868–872.

Tarnow, D.P., Emitaz, S. & Classi, A. (1997) Immediate loading of threaded implants at stage 1 surgery in edentulous arches: Ten consecutive case reports with 1- to 5-year data. *International Journal of Oral & Maxillofacial Implants* **12**: 319–324.