Implant Loading Protocols for the Partially Edentulous Esthetic Zone

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Purpose: *The scientific evidence related to different or novel implant loading (primary objective) and directly associated implant placement (secondary objective) protocols developed for the anterior maxillae of partially edentulous patients was reviewed.* **Materials and Methods:** *A comprehensive search of electronic databases and a hand search of six relevant journals was performed. The principal outcome variables were implant survival, implant success, and esthetic appearance. Concerning esthetic treatment outcomes, articles were specifically screened for the presence of objective evaluation parameters and patient satisfaction assessment.* **Results:** *The analysis of the literature on immediately restored or conventionally loaded implants in the esthetic zone revealed an initial survival rate of 97.3% after 1 year (10 prospective cohort studies and one case series). For periods of 1 to 5 years, the survival rate was 96.7%. These survival rates are consistent with previous reports on more traditional loading modalities. However, for immediately placed implants with immediate restoration and occlusal loading, the survival rate dropped by approximately 10% (four studies). Success criteria such as stable crestal bone levels, soft tissue recession, and probing depth could not be evaluated on the basis of the available literature.* **Conclusion:** *There is a paucity of prospective cohort studies addressing patient-centered outcomes. No parameters specific to immediate loading protocols were available for evaluation. In order to validate or reject such implant protocols for use in the esthetically sensitive anterior maxilla, long-term clinical trials should routinely include objective esthetic criteria that comprehensively embrace the pertinent elements of "pink and white esthetics" in the form of readily used indices.* Int J Oral Maxillofac Implants 2009;24(suppl):169–179

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In implant placement and implant loading protocols, there has been an increasing trend in recent years toward reducing both the time between tooth extraction and implant insertion, and the delay between implant placement and implant restoration. In fact, the traditional, more conservative guidelines established in the 1980s, suggesting a healing period of approximately 3 months after tooth removal and an osseointegration period of 3 to 6 months after implant placement, although leading to highly predictable outcomes, are currently more and more challenged. Furthermore, according to numerous authors, patients appear to be increasingly interested in reduced treatment time between tooth removal and delivery of the final implant-supported prosthesis, provided the level of predictability established during the previous two decades is maintained.

In the extreme, this involves insertion of an implant immediately after tooth extraction, potentially using simplified procedures such as flapless surgery, and subsequent restoration of the implant in the same session. Ultimately, this combination may not only lead to a reduction in the overall treatment time, but may also substantially decrease the associated costs. Furthermore, it has been claimed that the described approach is clearly associated with reduced surgical procedures and may more efficiently preserve the existing bone and soft tissues at the site of implantation.[1–7]

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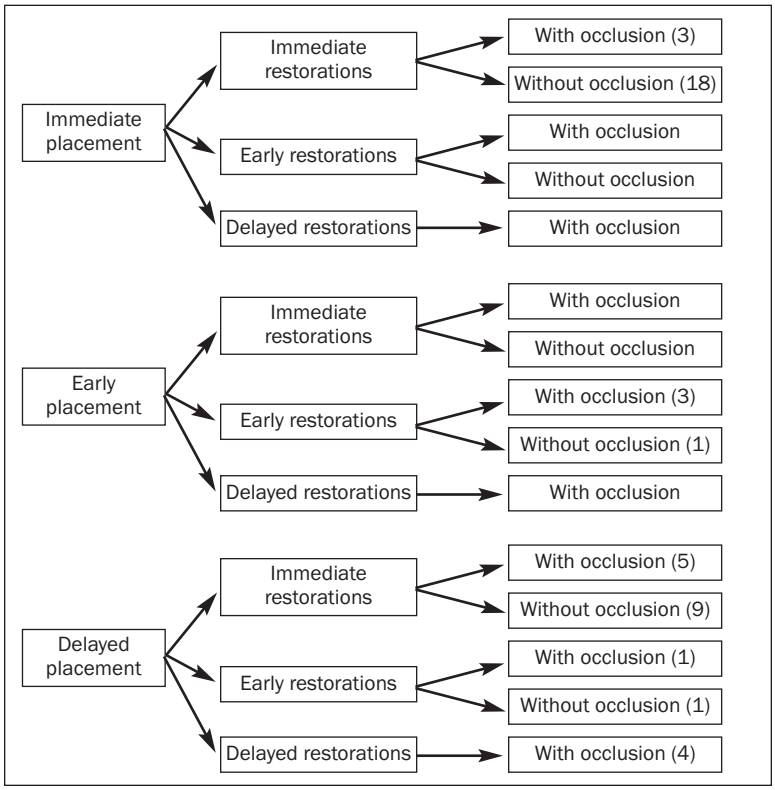

Fig 1 Diagram depicting the 15 theoretically possible options associated with the treatment variables *timing of placement*, *timing of restoration* and *with or without occlusion*. The respective number of studies corresponding to a particular placement-loading combination is shown in parentheses. Note that the majority of the 29 studies analyzed in this review—ie, 18 out of 29—refer to the combination of *immediate implant placement–immediate restoration (without occlusion).*

To date, several articles have provided evidence that the results associated with shortened treatment times after tooth extraction,[8] termed *immediate* or *early implant placement,* and/or after implant placement,[9] termed *immediate* or *early implant restoration*, may under well-defined conditions be similar to those reported for conventional protocols.[8–11] In a consensus report based on eight case series studies encompassing a total of 197 implants, Ganeles and Wismeijer stated that immediate implant restorations in extraction sockets appear to have longitudinal bone loss and soft tissue stability similar to those observed for traditionally loaded implants.[12]

Currently, the number of scientific mid- and long-term reports on combining immediate implant restoration with immediate implant placement is still limited. This is particularly true for information related to fixed implant restorations in the partially edentulous anterior maxilla that specifically comprises treatment outcome data based on objective esthetic criteria.

The aim of this review was to screen the recent literature for scientific evidence related to different or novel implant loading (primary objective) and directly associated implant placement (secondary objective) protocols developed for the anterior maxillae of partially edentulous patients. In this context, the following questions were addressed:

- How does immediate/early implant loading/restoration compare to traditional delayed/late loading in terms of implant survival, implant success, and long-term esthetic treatment outcome?
- Does the combination of immediate/early implant placement and immediate/early implant restoration affect (positively or negatively) implant survival, implant success, and long-term esthetic treatment outcome?

As a consequence, two distinct working hypotheses were tested:

- There is no correlation between implant loading/restoration protocols (immediate/early/late) and long-term implant success and esthetic outcome of anterior maxillary fixed implant restorations.
- There is no correlation between the combination of various implant placement/implant restoration protocols (immediate/early/late) and long-term implant success and esthetic outcome of anterior maxillary fixed implant restorations.

A diagram depicting the 15 theoretically possible treatment modalities based on the combination of the 3 main variables *timing of placement*, *timing of restoration,* and *presence or absence of direct occlusal contacts* is presented in Fig 1.

MATERIALS AND METHODS

Definitions

For the timing of implant placement after tooth removal and the timing of implant restoration, the following definitions established in the context of the Third ITI Consensus Conference[12] were used in this review:

Timing After Tooth Extraction:

- *Immediate implants:* Placement on the day of extraction
- *Early implants:* Placement 6 to 8 weeks after tooth extraction
- *Delayed/late/conventional implants:* Placement after 3 months or later

Timing of Loading/Restoration:

- *Immediate loading/restoration:* Within 48 hours after implant placement
- *Early loading/restoration:* > 48 hours and < 12 weeks
- *Delayed (conventional) loading:* 3 months or more after implant placement

Literature Survey

As traditional, delayed implant loading and delayed implant placement are well documented in the relevant literature, this review focused exclusively on recent studies reporting data that were associated with immediate and early implant restoration/loading protocols.

A computer search of multiple electronic databases, covering a time period from 2000 to May 2008, was performed. This time span was chosen due to the fact that the earlier literature had already been screened and analyzed in the process of the Third ITI Consensus Conference, which took place in 2003.

The following databases were consulted:

- Ovid MEDLINE, using the following key words: *dental implants, dental implantation, osseointegration, dental implants/single-tooth, dental prosthesis/implant-supported*
- The COCHRANE library—COCHRANE reviews, using the following key words: *dental implants, dental implants/single-tooth, immediate loading, dental prosthesis/implant-supported*
- PubMed search, using the following key words: *dental implants AND immediate placement, immediate loading, immediate function, early loading, early function*

Additionally, to assure optimum completeness of this literature screening, the following traditional literature search was performed:

- Hand search from 2000 to May 2008 of the content of the following six specialty journals: *Clinical Oral Implants Research, International Journal of Oral & Maxillofacial Implants, Journal of Implant Dentistry, Journal of Implant Dentistry and Related Research, International Journal of Periodontics & Restorative Dentistry,* and *Journal of Periodontology*
- Screening of the bibliographies of the following three topic-related review articles: Ganeles and Wismeijer 2004,[12] Ioannidou and Doufexi 2005,[13] and Esposito et al 2009[1]

In the first stage, all clinical studies corresponding to one of the following levels of the hierarchy of scientific evidence—ie, systematic reviews, randomized controlled trials, cohort studies, case-control studies, case series, or cross-sectional surveys—were evaluated. Case reports and expert opinions, as well as animal studies and presentations of clinical concepts and procedures, were not taken into consideration. However, only clinical studies reporting outcome data based on at least 12 months of follow-up were included for analysis. Furthermore, the respective implant survival rates had to be either directly reported or readily calculable. Finally, only studies implementing prosthetic rehabilitation protocols either within 48 hours after implant placement (*immediate loading/restoration*) or 3 to 8 weeks after implant insertion (*early loading/restoration*) were accepted.

Of 107 originally screened articles from the period 2000 to 2008, 29 publications satisfied the aforementioned inclusion criteria.[2–6,10,11,14–35] Those 29 articles reported on a total of 1,922 implants from 10 different implant manufacturers: Dentsply Friadent (Ankylos, XiVe, Frialit-2 Synchro), Nobel Biocare (Brånemark II, III, IV, Replace Select, Nobel Perfect, Sterioss, Alpha Bio), IMZ (Twin Plus), Straumann (SS, TE, BLI), Astra Tech (ST TiOblast, OsseoSpeed), Stabledent 1 piece, Southern Implant, Premium Implant, Biocom, and Biomet 3i (Osseotite) (Table 1).

Of the previously mentioned 29 articles, 20 studies fulfilled particular additional criteria in terms of containing data well-suited for statistical analysis[2–5,10,11,14–18,21,22,24–29,31] due to inclusion of results permitting direct comparisons between implants inserted in fresh extraction sites (test group) and implants placed in healed sites (control group). These studies are presented in Table 2.

Table 1 Studies Reporting Immediate, Early, and Delayed Loading Protocols of Anterior Implants

	Study	Study design	Implant system/ surface	Total no. of implants	Time of placement			Immediate restoration (patients/ implants)		Early restoration (patients/ implants)		Delay period	Delayed restoration (patients/ implants)	
					Immed	E	L	Occl	No occl	Occl	No occl		Occl	No occl
1	Malo et al (2000)[32]	Retrosp	Brånemark Mk II	94	27		67		49/94					
2	Ericsson et al (2000)[4]	Pilot	Brånemark Mk II	22			22	14/14					8/8	
3	Hui et al (2001)[27]	Preliminary report	Brånemark Mk III/IV	24	13		11		24/24					
4	Chaushu et al (2001)[16]	Clinical report	21 Sterio-Oss, 7 Alpha Bio HA	28	19		9	28/28*						
5	Andersen et al (2002)[14]	Prosp pilot	Straumann TPS	8			8				8/8	1 wk		
6	Lorenzoni et al (2003)[31]	Preliminary 1-year	Frialit-2 Synchro	12	8	4			8/8		1/4	8 wk		
7	Groisman et al (2003)[24]	Prosp	Nobel, Replace tapered	92	92				92/92					
8	Degidi and Piattelli (2003)[19]	Retrosp	Various	224	58				58/58					
8	Degidi and Piattelli (2003)[19]	Retrosp	Various	224	32				12/32					
8	Degidi and Piattelli (2003)[19]	Retrosp	Various	224	42				15/42					
9	Kan et al (2003)[28]	Prosp	Nobel, Replace	35	35				35/35					
10	Malo et al (2003)[33]	Prosp multicenter	Brånemark Mk II, III, IV	116	22		94		76/116					
11	Glauser et al (2003)[6]	Prosp	Brånemark IV TiUnite	102	23		79	102						
12	Drago and Lazzara (2004)[23]	Clinical report	Osseotite 3i	77	15		62		77/77					
13	Norton (2004)[35]	Prosp	Astra Tech ST TiOblast	28	16		12		25/28					
14	Locante (2004)[30]	Preliminary report	Stabledent 1-piece	86	46		40	86/86						
15	Degidi and Piattelli (2005)[20]	Prosp	Friadent XiVE	135	22				22/22					
15	Degidi and Piattelli (2005)[20]	Prosp	Friadent XiVE	135	14				6/14					
15	Degidi and Piattelli (2005)[20]	Prosp	Friadent XiVE	314			72						72/72	
15	Degidi and Piattelli (2005)[20]	Prosp	Friadent XiVE	314			19						6/19	
16	Cornelini et al (2005)[3]	Prosp	Straumann TE	22	22				22/22					
17	Ferrara et al (2006)[5]	Consecutive case series	Friadent Frialit-2 Synchro	33	33				33/33					
18	Degidi et al (2006)[21]	Prosp	Different: Frialit, IMZ, XiVE, Ankylos, Restore, Maestro, Brånemark	111	67		44		111/111					
19	De Kok et al (2006)[22]	Retrosp	Astra Tech ST TiOblast	43	43				25/39					
20	Lindeboom et al (2006)[29]	RCT	BioComp	50			50	25/25	25/25					
21	Barone et al (2006)[2]	Case series	Premium Impl	18	18				18/18					

Prosp = prospective; Retrosp = restrospective; RCT = randomized controlled trial; ant = anterior; max = maxilla; CI = central incisor; LI = lateral incisor; CA = canine;

Delay period	Placement zone	Single tooth	Adjacent implants	Follow-up time (mo)	Survival rate (%)	Success rate (%)	Esthetic index (yes/no)	Screw-retained/ cemented	Comments
	Ant max: 48 (CI, LI, CA) + 9 PM; ant mand: 29 (CI, LI, CA) + 8 PM	31		6–48	95.7 (4 lost)			Cemented	
12 wk	Ant max: 11 CI, 6 LI,1 CA; ant mand: 2 LI, 2 CA	22		18	Immed: 86 (2 lost); Late: 100		No	Cemented	
	Ant max: 20 CI, 3 LI, 1 CA	24		12–15	100 @ 1 y			Cemented	
	19 immediate: 2 max LI, 3 max CA, 9 max PM, 1 mand CA, 4 mand PM; 9 late: 2 max CI, 1 max LI, 1 max CA, 3 max PM, 2 mand PM	28		Immed: mean 13; Late: mean 16	Immed: 82.4 (3 lost); Late: 100		No	Screw-retained	*Central contact minimized
	Ant max: 7 CI, 1 LI	8		60	100			Screw-retained	
	5 CI, 7 LI	8	4 adjacent	Mean 13	100			Cemented	Occl guard for 8 wk
	Maxillary incisors	92		24	93.5 (6 lost)		Papilla index Jemt	Cemented	
	All over	58		Up to 54	96.6 (2 lost)	98.5 prosthetic		Both	
	Ant max not specific	NA	NA	Up to 54	100	100 prosthetic		Both	
	Ant mand not specific	NA	NA	Up to 54	100	100 prosthetic		Both	
	Ant max: 26 CA, 8 LI, 1 CA	35		12	100	100	Individual Papilla index	Cemented	
	74 Max: 15–25 42 Mand: 35–45	63	53	12	95.7 (5 lost); 93.7 single tooth, 98.1 splinted			Both	
		20		12	97.1	97.1 (3 lost)	No		Mixed group
	Max/mand nonspecific	77		18	97.4 (2 lost)		No	Cemented	
	Ant max: 16 CI, 8 LI, 1 CA + 3 PM	24	4 adjacent	8–27	96.4	96.4 (1 lost)		Bonded to coping	
	Ant max: 21 CI, 39 LI, 16 CA + 8 PM, 2 mand CA	86		36	98.8	98.8 (1 lost)		Cemented	
	All over	22		Up to 24	95.4	95.4 (1 lost)		Both	
	Ant max	NA	NA	Up to 24	100	100		Both	
12 wk	All over control group	72		Up to 24	100	100		Both	
12 wk	Ant max control group	NA	NA	Up to 24	100	100		Both	
	19 max + 3 mand/6 CI, 3 LI and 13 PM	22		12	100		Papilla index Jemt	Screw-retained	
	Ant max: 13 CI, 9 LI, 4 CA + 7 PM	33		48	93.9 (2 lost)		VAS @ 4 y = 9.3	Cemented	
	Ant max: 23 CI, 40 LI, 22 CA + 26 PM	111		60	95.5 (5 lost); immed: 92.5; late: 100	97.2	Papilla index Jemt	Both	
	Ant max: 12 CI, 9 LI, 5 CA + 13 PM	NA	NA		90.7 (4 lost)			Cemented	
	Load: 14 ant max + 11 PM; Nonload: 16 ant max + 9 PM	46	4 adjacent (2 x incisors)	12	Occl 23/25 (92%); no occl 22/25 (88%)		Papilla index Jemt	Screw-retained	
	5 max CI, 8 max PM, 2 mand CA, 3 mand PM	18		12	94.5 (1 lost)			Cemented	

PM = premolar; mand = mandible; immed = immediate; NA = not applicable; occl = occlusal; no occl = not occlusal; E = early; L = late.

Table 1 continued Studies Reporting Immediate, Early, and Delayed Loading Protocols of Anterior Implants

	Study	Study design	Implant system/ surface	Total no. of implants	Time of placement			Immediate restoration (patients/ implants)		Early restoration (patients/ implants)		Delay period	Delayed restoration (patients/ implants)	
					Immed	E	L	Occl	No occl	Occl	No occl		Occl	No occl
22	Noelken et al (2007)[34]	Prosp	Nobel Perfect	31	21		10		20/31					
23	Cooper et al (2007)[17]	Prosp cohort	Astra Tech ST TiOblast	54			54			48/54		3 wk		
24	Harvey (2007)[26]	Case series	Astra Tech OsseoSpeed	36	36					36/36				
25	Hall et al (2007)[25]	RCT	Southern rough/ tapered	28			28			14/14			14/14	
26 27	Buser et al (2008)[10]/ Belser et al (2009)[15]	Cross-sectional retrosp	Straumann SLA	45		45			45			8 wk		
28	Buser et al (2009)[11]	Prosp case series	Straumann BL SLactive	20		20			20			8 wk		
29	Cornelini et al (2008)[18]	RCT	Straumann SLA	34	34				34					
Totals				1,922	758	69	681	255	1,005	119	12		113	

Prosp = prospective; Retrosp = restrospective; RCT = randomized controlled trial; ant = anterior; max = maxilla; CI = central incisor; LI = lateral incisor; CA = canine;

Data Extraction

Subsequently, the following data were extracted from each study:

- Study design (according to the respective definitions of evidence-based dental medicine)
- Implant manufacturer, implant type, implant surface
- Total number of implants per study
- Time of implant placement (immediate/early/late)
- Time of implant restoration (immediate/early/late)
- Loading type (restoration with or without occlusion)
- Location of implants
- Type of therapy: single-tooth or adjacent implants
- Follow-up time
- Survival rate
- Success rate
- Esthetic outcome assessment (yes/no)
- Type of restoration: screw-retained or cemented

In the process of data analysis, the principal outcome variables *implant survival, implant success,* and *esthetic appearance* were addressed. Concerning esthetic treatment outcomes, the study results were specifically screened for presence of objective evaluation parameters, such as the *papilla index* described by Jemt,[36] the *pink and white esthetic score* (*PES/WES*) *index*,[11,15,37] and patient satisfaction assessment based on *visual analog scale* (*VAS*) analysis.[5,15,38]

RESULTS

In terms of the implemented treatment modalities investigated in the 29 studies, the large majority—ie, 18 studies—addressed the combination *immediate implant placement, immediate restoration, absence of direct occlusal load*; 3 studies evaluated *immediate implant placement, immediate restoration, presence of direct occlusal load*; 3 studies focused on *early implant placement, early restoration, presence of direct occlusal load*; and 1 study analyzed *delayed implant placement, early restoration, presence of direct occlusal load* (see Fig 1).

Of the 1,922 total implants encompassed by the 29 publications, 1,120 represented anterior single-tooth replacements. After an observation time of 12 to 60 months, independent of the treatment modality, an overall implant survival rate of 96.6% was calculated (Table 1). It should be noted that none of the studies made a distinction between implant survival and prosthesis survival.

Implant Survival

The 21 studies that reported on 758 implants inserted in fresh extraction sites, and which were subsequently immediately restored either with or without direct occlusal contacts, revealed an overall survival rate of 96.6% for an observation period of up to 60 months.

Delay period	Placement zone	Single tooth	Adjacent implants	Follow-up time (mo)	Survival rate (%)	Success rate (%)	Esthetic index (yes/no)	Screw-retained/ cemented	Comments
	Ant max 24 (CI + CA + PM) + 7 mand CI	14	17	Up to 27	96.8	96.8 (1 lost)	PES	Cemented	
	Ant max @ 3y 15 CI, 21 LI, 7 CA	43		36	94.4 (3 lost)		Papilla index Jemt	Cemented	8 withdrawals
	Ant max not specific	36		18	100			Screw-retained	
26 wk	Ant max: 15 to 25	28		12	96.4 (1 lost)		Papilla index Jemt	Screw-retained	
	Ant max: 26 CI, 11 LI, 3 CA, 5 PM	45		24–48	100	100	PES/WES	Screw-retained	
	Ant max: 14 CI, 3 LI, 1 CA, 2 PM	20		12	100	100	PES/WES	Screw-retained	
	Ant max: 13 CI, 21 PM	34			100		Papilla index Jemt	Screw-retained	
		1,120			96.6				

PM = premolar; mand = mandible; immed = immediate; na = not applicable; occl = occlusal.

More specifically, the mean implant survival rate calculated for the immediate restoration/without occlusion group (based on 18 studies; N = 1,005 implants; mean observation time approximately 23.6 months; range 12 to 60 months) was 97.1%, and the rate calculated for the immediate restoration/with occlusion group (based on 3 studies; N = 216 implants; mean observation time 20.3 months; range 12 to 36 months) was 92.8%.

For early restoration/loading (five publications; 131 implants), the overall survival rate, independent of the timing of implant placement, amounted to 98.9%. A prospective cohort study involving 54 implants that had been inserted in healed sites reported survival rates of 96.2% after 12 months and 94.4% after 36 months.[7,17] If one looks, still in the context of early loading, separately at the two studies based on implants inserted according to the concept of early implant placement, an implant survival rate of 100% was published after follow-up periods of 12 months[10] and 24 to 48 months.[11]

Finally, all three studies reporting on delayed implant loading in the context of controlled prospective trials published 100% survival rates.[4,20,25] It should be noted that all of the included implants had been inserted in healed extraction sites.

Implant Success

Ten of the 29 studies also presented success rates when reporting treatment outcomes, with the mean implant success rate being 98.6%. Only 1 retrospective study specifically mentioned a prosthetic success rate, which corresponded to 98.5%.[19]

Esthetic Evaluation

In 12 studies the authors mentioned the use of a structured esthetic evaluation protocol, with 7 of these using a papilla index analysis, as proposed by Jemt.[36] In 1 study the level of subjective patient satisfaction was evaluated by means of questionnaires based on a VAS. Finally, 1 retrospective[11] and 1 prospective[15] case series study implemented the so-called "pink and white esthetic score" (PES/WES) index, a further development of the pink esthetic score originally published by Fürhauser and coworkers in 2005.[37]

Miscellaneous

In 9 of the 29 studies the anterior implant restorations were exclusively of the screw-retained type, while in 13 investigations cemented suprastructures were consistently utilized. Two groups of authors published data based on both respective restorative options.[19–21,33]

Table 2 Studies Reporting Immediate, Early, and Delayed Loading Protocols of Anterior Implants Fulfilling All Inclusion Criteria

	Study	Study design	Implant system/ surface	Total no. of implants	Time of placement			Immediate restoration (patients/ implants)		Early restoration (patients/ implants)		Delay period	Delayed restoration (patients/ implants)	
					Immed	E	L	Occl	No occl	Occl	No occl		Occl	No occl
1	Ericsson et al (2000)[4]	Pilot	Brånemark Mk II	22			22						8/8	
1	Ericsson et al (2000)[4]	Pilot	Brånemark Mk II	22			22	14/14						
2	Hui et al (2001)[27]	Preliminary report	Brånemark Mk III/IV	13	13				13/13					
2	Hui et al (2001)[27]	Preliminary report	Brånemark Mk III/IV	11			11		11/11					
3	Chaushu et al (2001)[16]	Clinical report	21 Sterio-Oss, 7 Alpha Bio HA	19	19			19/19						
3	Chaushu et al (2001)[16]	Clinical report	21 Sterio-Oss, 7 Alpha Bio HA	9			9	9/9						
4	Andersen et al (2002)[14]	Prosp pilot	Straumann TPS	8			8				8/8	1 wk		
5	Lorenzoni et al (2003)[31]	Preliminary 1-year	Frialit-2 Synchro	12	8	4			8/8		1/4	8 wk		
6	Groisman et al (2003)[24]	Prosp	Nobel, Replace tapered	92	92				92/92					
7	Kan et al (2003)[28]	Prosp	Nobel, Replace	35	35				35/35					
8	Cornelini et al (2005)[3]	Prosp	Straumann TE	22	22				22/22					
9	Ferrara et al (2006)[5]	Consecutive case series	Frialit-2 Synchro, Friadent	33	33				33/33					
10	Degidi et al (2006)[21]	Prosp	Different: Frialit, IMZ, XiVE, Ankylos, Restore, Maestro, Brånemark	67	67				67/67					
10	Degidi et al (2006)[21]	Prosp	Different: Frialit, IMZ, XiVE, Ankylos, Restore, Maestro, Brånemark	44			44		44/44					
11	De Kok et al (2006)[22]	Retrosp	Astra Tech ST TiOblast	43	43				25/39					
12	Lindeboom et al (2006)[29]	RCT	BioComp	50			50	25/25	25/25					
13	Barone et al (2006)[2]	Case series	Premium Impl	18	18				18/18					
14	Cooper et al (2007)[17]	Prosp cohort	Astra Tech ST TiOblast	54			54			48/54		3 wk		
15	Harvey (2007)[26]	Case series	Astra Tech OsseoSpeed	36	36				36/36					
16	Hall et al (2007)[25]	RCT	Southern rough/ tapered	28			28		14/14				14/14	
17,18	Buser et al (2008)[10]/ Belser et al (2009)[15]	Cross-sectional retrosp	Straumann SLA	45		45							45	
19	Buser et al (2009)[11]	Prosp case series	Straumann BL SLactive	20		20							20	
20	Cornelini et al (2008)[18]	RCT	Straumann SLA	34	34				34					
Totals				715	420	69	226	67	495					

The studies highlighted with a darker background identify those comprising two distinctly different cohorts (test/control).
Prosp = prospective; Retrosp = restrospective; RCT = randomized controlled trial; ant = anterior; max = maxilla; mand = mandible; CI = central incisor; LI = lateral incisor; CA = canine;

DISCUSSION

Based on the analysis of 29 clinical studies, all reporting outcome data on implant therapy performed in the anterior segments of the jaws of partially edentulous patients and consistently applying either immediate or early implant restoration/loading protocols, an overall implant survival rate of 96.6% for an observation period of up to 5 years clearly underlines the high level of predictability of these specific treatment modalities. This includes protocols combining both immediate implant placement and immediate implant restoration, provided there is an absence of direct occlusal contact during the osseointegration phase.

Furthermore, it has been demonstrated in particular that anterior maxillary single-tooth implant replacement, with implants inserted and restored according to the concept of early implant placement and early implant restoration, is a successful and highly predictable treatment modality in general, and from an

Delay period	Placement zone	Single tooth	Adjacent implants	Follow-up time (mo)	Survival rate (%)	Success rate (%)	Esthetic index (yes/no)	Screw-retained/ cemented	Comments
12 wk	4 CI, 3 LI, 1 mand CA	8		18	100		No	Cemented	
	7 CI, 3 LI, 1 CA, 2 mand LI, 1 mand CA	14		18	86 (2 lost)		No	Cemented	
	Ant max: 20 CI, 3 LI, 1 CA	13		12–15	100 @ 1 y			Cemented	
	Ant max: 20 CI, 3 LI, 1 CA	11		12–15	100 @ 1 y			Cemented	
	2 max LI, 3 max CA, 9 max PM, 1 mand CA, 4 mand PM	19		13	82.4 (3 lost)		No	Screw-retained	*Central contact minimized
	2 max CI, 1 max LI, 1 max CA, 3 max PM, 2 mand PM	9		16	100		No	Screw-retained	*Central contact minimized
	Ant max: 7 CI, 1 LI	8		60	100			Screw-retained	
	Ant max: 5 CI, 7 LI	12	4 adjacent	13	100			Cemented	Occl guard for 8 wk
	Maxillary incisors	92		24	93.5 (6 lost)		Papilla index Jemt	Cemented	
	Ant max: 26 CI, 8 LI, 1 CA	35		12	100	100	Individual Papilla index	Cemented	
	19 max + 3 mand / 6 CI, 3 LI and 13 PM	22		12	100		Papilla index Jemt	Screw-retained	
	Ant max: 13 CI, 9 LI, 4 CA + 7 PM	33		48	93.9 (2 lost)		VAS @ 4 y = 9.3	Cemented	
	Ant max: 23 CI, 40 LI, 22 CA + 26 PM	67		60	92.5	97.2	Papilla index Jemt	Both	
	Ant max: 23 CI, 40 LI, 22 CA + 26 PM	44		60	100	97.2	Papilla index Jemt	Both	
	Ant max: 12 CI, 9 LI, 5 CA + 13 PM	39	NA		90.7 (4 lost)			Cemented	
	Load 14 ant max + 11 PM; Nonload 16 ant max + 9 PM	46	4 adjacent (2 x incisors)	12	Load 23/25 (92%) / Nonload 22/25 (88%)		Papilla index Jemt	Screw-retained	
	5 max CI, 8 max PM, 2 mand CA, 3 mand PM	18			12	94.5 (1 lost)			Cemented
	Ant max at 3 y 15 CI, 21 LI, 7 CA	43		36	94.4 (3 lost)		Papilla index Jemt	Cemented	8 withdrawals
	Ant max not specific	36		18	100			Screw-retained	
26 wk	Ant max: 15 to 25	28		12	96.4 (1 lost)		Papilla index Jemt	Screw-retained	
8–12 wk	Ant max: 26 CI, 11 LI, 3 CA, 5 PM	45		24–48	100	100	PES/WES	Screw-retained	
8–12 wk	Ant max: 14 CI, 3 LI, 1 CA, 2 PM	20		12	100	100	PES/WES	Screw-retained	
	Ant max: 13 CI, 21 PM	34			100		Papilla index Jemt	Screw-retained	
		696			95.85				

PM = premolar; NA = not applicable; occl = occlusal; No occl = No occlusal; Immed = immediate; E = early; L = late.

esthetic point of view in particular.[10,11,15] In this context, the pertinence of evaluation tools such as the PES/WES index for the objective outcome assessment of the esthetic dimension of anterior single-tooth implants has been confirmed.

Implant dentistry has constantly evolved toward simplification of clinical procedures and shortened treatment times, with such developments as flapless surgery and immediate implant placement.[39–41] Studies that have applied these protocols mostly report short- and mid-term implant survival and success rates similar to those of more traditional treatment approaches. However, when it comes to their routine implementation in the anterior maxilla, these protocols may lead to less favorable results from an esthetic point of view, as for example recessions of the facial peri-implant mucosa. In fact, the recently published evidence suggests that immediately placed but not yet restored implants in the esthetic zone yield a significant number of sites with soft tis-

sue recession (approximately 40%).[39–41] For immediately placed and immediately loaded implants, such data do not exist.

In order to validate or reject such implant protocols for use in the esthetically sensitive anterior maxilla, respective clinical long-term trials should routinely include objective esthetic criteria when assessing outcomes. These criteria should comprehensively embrace the pertinent elements of the so-called "pink and white esthetics," preferably in the form of an easy-to-use index.

In an attempt to define decision-making criteria for the choice between immediate and early implant restoration, the following recommendations may be proposed.

Immediate Implant Restoration and Loading

- Immediate restoration and loading can be used when the implant is of adequate length (≥ 8 mm) and diameter (≥ 4 mm) and the implant achieves "good" primary stability.
- The restoration should be taken out of any functional occlusal contacts both in centric occlusion and during excursive mandibular movements.
- The restoration should not be removed during the healing period of approximately 6 weeks. The patient should be instructed in how to function during the healing period and how to perform adequate oral hygiene.
- Screw-retained provisional restorations are recommended.
- Patients with parafunctional occlusal habits should be fitted with a habit appliance.
- Immediate restoration and loading can be used when the bone volume at the site is close to ideal, ie, when either minimal or no simultaneous guided bone regeneration procedures are required.

Early Loading

- Early loading is defined as 1 week to 2 months. This involves a more conservative approach and minimal augmentation procedures. Since current surface technologies show adequate bone contact at 3 weeks, it might be considered favorable to wait until the third week or later for an early loading protocol. Abutment and provisional placement could be accomplished at the determined time. A final impression is considered depending on soft tissue maturity. Final restoration and torque to 35 Ncm occur at 6 to 8 weeks.
- Patients with parafunctional habits should wear a habit appliance.

CONCLUSIONS

The analysis of the literature on immediately restored or conventionally loaded implants in the esthetic zone revealed an initial survival rate of 97.3% after 1 year. This is based on 10 prospective cohort studies and 1 case series. With an observation period of more than 1 year, but not more than 5 years, the respective survival rate was 96.7%, indicating an additional implant loss of 0.5% between years 2 and 5.

The survival rates, therefore, are consistent with previously reported survival rates of other modalities of implant restoration. However, when the implant is placed immediately after the extraction, with an immediate restoration and occlusal load, the survival rate drops by approximately 10% (4 studies).

One randomized controlled trial involving 50 implants placed in healed sites of the esthetic zone, however, indicated a lower survival rate (88%) for conventionally loaded implants when compared to immediately loaded (92%) implants after 1 year. It should be noted that this difference was due to a single implant lost.

Success criteria such as bone levels, soft tissue recession, and probing depth cannot be evaluated on the basis of the available literature.

There is a paucity of prospective cohort studies addressing patient-centered outcomes. No parameters specific to immediate loading protocols were available for evaluation.

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