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A systematic review of survival of single implants as presented in longitudinal studies with a follow-up of at least 10 years

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Background: Placement of single implants is one of the most common applications for implant treatment. Millions of patients have been treated worldwide with osseointegrated implants and many of these patients are treated at a young age with a long expected remaining lifetime. Therefore long-term evidence for such treatment is important.

Aim: To report patient treatment, implant and implant-supported single crown survival over at least a 10-year period of follow-up. Material and methods: After reviewing long-term publications, included by Jung et al (2012), a complementary PubMed search was performed using the same search strategy for the period September 2011 to November 2014. Data on implant and single implant crown treatment survival were compiled from included studies.

Results: Four new publications were identified from the 731 new titles. They were added to an earlier list of five manuscripts by Jung et al (2012) , which were already included. Accordingly, nine publications formed the database of available long-term evaluations. The database consisted of 421 patients altogether, provided with 527 implants and 522 single crowns. From the 367 patients that were followed-up for at least 10 years (87%), altogether 502 implants were still in function at the completion of the studies (95.3%), supporting 432 original and 33 remade single implant crowns. Based on patient level and implant level data, implant survival reached 93.8% and 95.0%, respectively. The corresponding survival rate for original crown restorations was 89.5%.

Conclusions: Single implant treatment is a predicable treatment over a 10-year period of time, with no indication of obvious changes in implant failure rate between 5 and 10 years. However, replacement of new single crowns must be considered during the follow-up as part of regular maintenance. Compared to the number of treated patients worldwide, the available numbers with a follow-up of 10 years was low.

Introduction

Today, implant-supported single crowns can be regarded as a favourable treatment option for single tooth gaps. From a health economic viewpoint implant-supported single crowns have been suggested to be preferable to tooth-supported 3-unit prostheses[1]. Furthermore, implant-supported single crowns are tooth-tissue preserving in comparison to tooth-supported prostheses and their 10-year survival seems to be 10% higher[2,3]. In addition, with the development of treatment procedures such as bone and soft tissue augmentation and development of crown and abutment materials, an increased aesthetic outcome can be achieved[4,5]. Single tooth gaps may often result from trauma at a young age,

associated with sport activities or traffic accidents. Another common cause in young patients can be aplasia of one or more teeth. As a consequence, many patients are young and start their implant treatment in late adolescence. Thus, due to the youth of the patients, the implant-supported single crowns should hopefully remain in place for decades and with as few complications as possible during this time span.

In a systematic review, Jung et al reported the survival of implants supporting single crowns and of implant-supported single crowns[6]. After five years, the calculated survival of implants was 97.2% (95% CI: 96.3 to 97.9%), and 96.3% (95% CI: 94.2 to 97.6%) for implant-supported single crowns. Cumulative incidence of technical, biological and aesthetic complications was also calculated[6]. Yet, even though long-term, up to 10-year results were also estimated, the review was basically limited to longitudinal studies with a mean follow-up time of 5 years[6]. Considering the youth of many patients at the time of treatment, as mentioned above, there is a need for reviews of studies with a longer follow-up time than 5 years.

The aim of the present review was therefore to assess the 10-year survival of single implants and implant-supported single crowns, and to present the incidence of biological and technical complications.

Material and methods

Search strategies

In the present review, two search strategies were used. First, the total reference list of included studies from a recent previous systematic review on single implants was screened[6]. In the second search, a PubMed search was performed for studies published from September 2011 to November 2014, and limited to the English language, based on search terms, as used by Jung et al[10]. The search terms were (((((complication* AND Humans [Mesh])) OR (((survival) OR survival rate) AND Humans [Mesh])) AND Humans [Mesh])) AND dental implants [MeSH Terms]. The two searches were complemented by manual searches of the reference lists of all full-text studies selected from the electronic search and associated reference lists.

Inclusion criteria

- Original studies on humans with a minimum amount of 15 patients with single crowns.
- Assumed minimum follow-up of at least 10 years for the majority of patients i.e. this means that a mean follow-up time of 9.5 years could be accepted.
- Less than 50% of dropouts.
- Data reported on patient level, where single implant patients could be identified as a group if mixed groups of partially edentulous patients were followed-up.
- Randomised controlled trials, controlled clinical trials, prospective case series, cohort studies and retrospective studies.

Exclusion criteria

- Studies not meeting all inclusion criteria.
- Studies not reporting on numbers of all patients included and lost to follow-up.
- Studies not reporting on implant survival.
- Studies based on questionnaires, interviews and charts.

Selection of studies

The three authors screened the titles from the studies found in the two broad searches independently, considering the inclusion criteria. After discussion, disagreements were resolved. In the next step, abstracts of all studies agreed upon, were obtained and screened according to the inclusion criteria by the three authors, independently of each other. Once selected, the full texts of the studies were acquired. These publications were again independently scrutinised and a final discussion took place to reach a consensus. All selected studies were then examined and analysed (Fig 1).

Extraction of data and analysis

Data from all included studies were extracted by using data extraction forms. Information on the survival of the single crowns and of biological and technical complications was retrieved. 'Survival' was defined as the implant/restoration remaining *in situ*

at follow-up examination visits. The three authors checked the extracted data, and eventual disagreements were discussed until a consensus was reached. The numbers of events were extracted and the corresponding total exposure time of the single crowns was calculated.

Statistical analysis

In the present report, descriptive data are presented as numbers and frequencies. Mean values have been calculated as weighted values based on the individual group mean value and number of participating patients. Data are being presented on 'patient', 'implant' and 'crown restoration' levels. Survival rates were calculated as:

Survival rate (%) = (1-(failures/(included-(dropouts/2)))*100

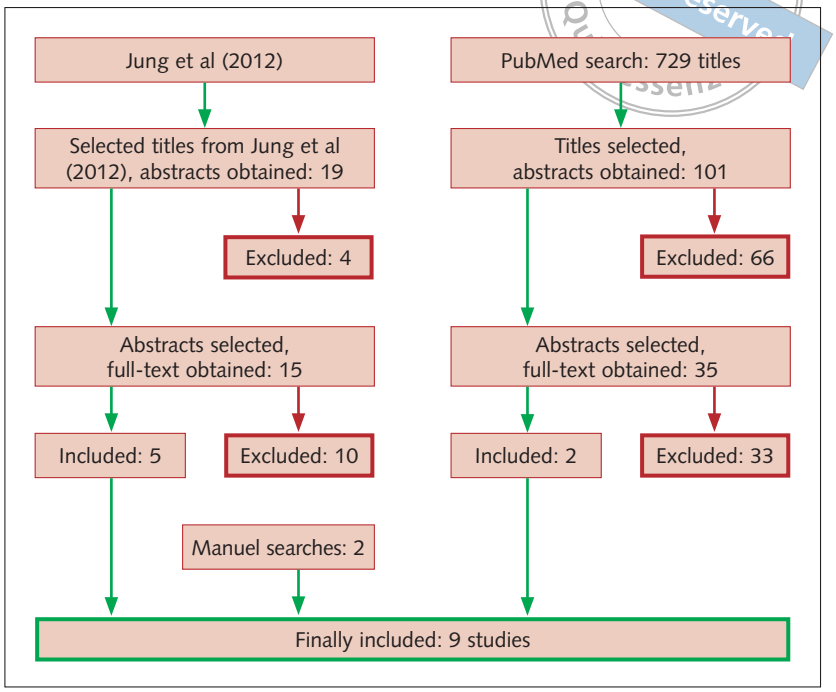

Fig 1 Search strategies and results for the previous review by Jung et al (2012), the complementary PubMed search from September 2011 to November 2014 and the manual search.

Results

From the reference list from the previous review by Jung et al[6], 19 abstracts were selected. Full-text articles from 15 of these were scrutinised, including 8 out of 10 studies referred to as long-term studies by Jung, and finally, five studies were selected for the present review. These five included studies corresponded to 'long-term/10-year' studies included by Jung et al[6] (Fig 1).

The new PubMed search resulted in 729 study titles. Abstracts were scrutinised from the 101 study titles selected. Full-text articles were obtained from 35 of these abstracts. Finally, two of these studies were included in the present review and consequently, 33 were excluded. The manual searches resulted in two additional studies. The main reasons for exclusion of the 43 reviewed full-text articles were:

- Mixed data or not reported at single crown restoration level (n =18).
- Less than 10 years of follow-up or unclear follow-up time (n = 8).
- Less than 15 patients included (n = 6).
- Dropout exceeding 50% (n = 5).
- Review studies (n = 4).
- Not reporting on the number of all patients included and lost to follow-up (n = 2).

Accordingly, nine studies were included in the study, four prospective and five retrospective ones (Table 1). Treatment had been performed in specialist clinics in five studies and in a university setting in four studies. None had been performed in a general dentistry clinic.

Altogether 421 patients were treated with single implants at a calculated average age of 36.3 years (Table 1). In total, 60 patients were lost to follow-up (14.3%), while the remaining patients (n = 361) were followed up for a calculated average of 11.7 years (range 7.5 to 19 years). Patients were provided with 527 single implants from at least four different implant manufactures and had both turned and moderately rough surfaces (Table 1; one publication – 'not reported system'). Implants were placed using both one- and two-stage surgery protocols in both the maxilla and mandible and in both anterior and posterior parts of the jaw. Most of the included studies covered Brånemark System implants (Nobel Biocare AB, Göteborg, Sweden) with a turned implant surface (Tables 1 and 2).

The patients were provided with 522 single implant crown restorations, with the majority reported as porcelain fused to metal restorations (n = 283),

Table 1 Study design and patient characteristics; N = number of patients, N/A = not available/reported.

Study		Patients			Follow-up				Implant system	Clinical Setting
Author (Year of publication)	Design	N	Mean age	Age range	Dropout (%)	Dropout (No. of patients)	Mean time (years)	Range (years)		
Thilander et al (2001)	Prospective	15	15.3	13-17	0	0	10	N/A	Brånemark	Specialist clinic
Jemt (2008)	Retrospective	38	25.4	NA	29	11	15	N/A	Brånemark	Specialist clinic
Jemt (2009)	Retrospective	35	31.3	18-75	31	11	10	N/A	Brånemark	Specialist clinic
Gotfredsen (2009)	Prospective	20	33.0	18-59	5	1	10	N/A	Astra Tech	University
Bonde et al (2010)	Retrospective	51	43.0	19-79	12	6	10	7.5-12.0	Brånemark	University
Matarasso et al (2012)	Retrospective	80	47.3	NA	7.5	6	10	N/A	Brånemark Straumann	University
Covani et al (2012)	Prospective	98	N/A	23-75	7.1	7	10	N/A	Premium	Specialist clinic
Bergenblock et al (2012)	Prospective	57	31.9	15-57	16	9	18.4	17.0-19.0	Brånemark	Specialist clinic
Misje et al (2013)	Retrospective	27	N/A	17-41	33	9	N/A	12.0-15.0	N/A	University
Total		**421**	**36.3**	**14-79**	**14.3**	**60**	**11.7**	**7.5-19**		

Table 2 Implants and single crown restorations; N/A = not available/reported.

Study	Patients	Implants	Single crowns					
Author (age)	Number included	Number included	Number included	Sites / jaws	Cemented	Screw retained	Metal / ceramics	All ceramics
Thilander et al (2001)	15	29	29	Maxilla / Mandible	15	0	15	0
Jemt (2008)	38	47	47	Anteririor Maxilla	47	0	47	0
Jemt (2009)	35	41	41	Incisors / premolars	23	18	41	0
Gotfredsen (2009)	20	20	20	Anteriror Maxilla	20	0	20	0
Bonde et al (2010)	51	55	52	Maxilla / Mandible	52	0	N/A	N/A
Matarasso et al (2012)	80	80	80	Maxilla / Mandible	N/A	N/A	N/A	N/A
Covani et al (2012)	98	159	157	Incisors / premolars	0	157	157	0
Bergenblock et al (2012)	57	65	65	Maxilla / Mandible	65	0	3	62
Misje et al (2013)	27	31	31	Anterior Maxilla	N/A	N/A	N/A	N/A
Total	**421**	**527**	**522**		**222**	**175**	**283**	**62**

and some as all-ceramic crowns (Table 2; n = 62). Two hundred and twenty-two of the crowns were reported as 'cemented' and 175 as 'screw retained' (Table 2). However, data were not available to distinguish between crowns that were cemented to the abutment and screw retained thereafter, and those that were cemented directly onto the abutment, without access screw holes in the oral cavity.

Altogether 25 implants were removed during follow-up, in presumably 25 different patients (Table 3). Five of these implants were reported to be lost before crown placement. No detailed information over time was available to allow for calculation of a 'patient survival' / 'implant survival' life table. No study reported implant survival rate at 'patient level'. Four studies reported no implant failures at all during follow-up. The remaining studies reported an implant failure rate between 3.2% and 8.2%, corresponding to an implant survival rate between 91.8% and 96.8%, respectively (Table 4). An overall estimation of implant survival in the database on 'patient level' was calculated at 93.8%. Correspond-

Table 3 Complications and failures at implants and single crown restorations; N/A = not available/reported.

Study	Patients	Implants			Original single crowns				
Author	Included	Placed	Failures	Mean bone loss	Placed	Followed up*	Porcelain fractures	Loose	Remade
Thilander et al (2001)	15	29	0	N/A	29	29	N/A	N/A	0
Jemt (2008)	38	47	0	0.7	47	25	1	1	11
Jemt (2009)	35	41	0	0.3	41	29	N/A	5	1
Gotfredsen (2009)	20	20	0	N/A	20	18	2	2	2
Bonde et al (2010)	51	55	3	N/A	52	46	3	3	3
Matarasso et al (2012)	80	80	6	2.1	80	74	N/A	N/A	N/A
Covani et al (2012)	98	159	13	N/A	157	144	2	9	2
Bergenblock et al (2012)	57	65	2	0.8	65	48	2	2	8
Misje et al (2013)	27	31	1	1.5	31	16	4	1	6
Total	**421**	**527**	**25**	**1.3**	**522**	**429***	**14**	**23**	**33**

* No accurate data available for individual studies; numbers estimated to be in total between 429 and 434 original crowns (mean 432 original crowns).

Table 4 Reported and estimated patient / implant and single implant crown failure rates over >10 years of follow-up.

Study	Patients*		Reported failure rate (%)		Estimated >10 year survival (%)		
Author	Included	End	Implants	Crowns	Patients*#	Implants*	Crowns*
Thilander et al (2001)	15	15	0.0	0.0	100.0	100.0	100.0
Jemt (2008)	38	27	0.0	23	100.0	100.0	76.6
Jemt (2009)	35	24	0.0	N/A	100.0	100.0	97.6
Gotfredsen (2009)	20	19	0.0	10.0	100.0	100.0	90.0
Bonde et al (2010)	51	45	6.0	6.0	94.1	94.5	94.2
Matarasso et al (2012)	80	80	7.5	N/A	92.5	92.5	N/A
Covani et al (2012)	98	91	8.2	N/A	86.7	91.8	91.8
Bergenblock et al (2012)	57	48	3.2	16.2	96.5	96.9	84.6
Misje et al (2013)	27	18	4.5	4.5	96.3	96.8	77.4
Total/mean (Range)	**421**	**367**	**(0.0-8.2)**	**(0.0–23.0)**	**93.8 (86.7–100.0)**	**95.0 (91.8–100.0)**	**89.5 (76.6–100.0)**

* calculations based on inclusion data
# estimated; assumed one implant failure per patient

ing estimation of survival rate on 'implant level' was 95.0%. Implant level survival rates showed a variation between the studies, reported from 91.8% to 100.0% (Table 4). Mean marginal bone loss during the entire follow-up was reported in five studies, ranging from 0.3 mm to 2.1 mm (Table 3). An overall mean bone loss was calculated to reach 1.3 mm during 10 years of follow-up.

It was estimated that 37 of the crowns had been lost to follow-up due to various reasons (dropout). Another 20 crowns were lost due to implant failure and 33 were remade (Table 3). Accordingly, it was estimated that 432 of 522 original single crown restorations were followed up for the entire 10-year period (Table 3). Overall original single crown survival rate was estimated to be 89.5% (Table 4). Reasons for remaking the single crowns were reported as aesthetical or technical, i.e. fractures of veneer material and implant crown infraposition. Available data in the publications were not considered suitable to allow for a detailed presentation of these observations.

Discussion

Single implant treatment is today one of the most common implant treatment options worldwide. From the millions of patients provided with oral implants, a significant proportion received single implant restorations. It can be assumed that many of them belong to the young age group, thus with a long remaining lifetime. It is therefore important to collect data on clinical long-term outcome of single implant restorations. Altogether nine studies, four prospective and five retrospective, fulfilling the present inclusion criteria could be selected (Figure 1). The present review is based on studies included in the literature review by Jung et al[6], complemented with a similar PubMed search, but up to the end of 2014. The present included studies report altogether on 421 patients, where 367 patients were followed for 10 years or more (Table 4). However, these patients cover only a small fraction of all single implant patients that have been treated worldwide, and accordingly, long-term evidence for single implant treatment must be considered to be low. Furthermore, the treatments described in the studies included in the present review were all performed in specialist clinics or university hospitals, and not in general practice.

In the present review, a calculated mean of only 14.3% of the patients were lost to follow-up which must be considered as a low dropout ratio for 10 years of follow-up. One reason for this high level of compliance might be that the performed implant treatments described in a number of the included studies were following new treatment protocols as pioneer groups (Thilander et al 2001, Gotfredsen 2012 and Bergenblock et al 2012). As a consequence, the included patients can be considered to be highly motivated both for the treatment, but also for the follow-up and the results may not necessarily reflect clinical results in daily practice.

Interpretation of the clinical outcome of oral implants is often difficult since different investigators neither use similar study designs nor success and survival criteria. Furthermore, patient selection and dropouts are often improperly described and there are frequently variations in follow-up time of the patients, even in a single study. Yet, however desirable, it does not seem realistic to perform a large scale high quality randomised, double-blinded, prospective clinical trial for long-term evaluation of implant prosthodontics. In many situations treatment protocols may have changed so much over time that studied protocols are not in use any more at termination of the study. This raises both cost and ethical considerations[7,8]. As an alternative strategy, systematic reviews can be regarded as tools for the clinicians to make appropriate clinical decisions in individual patients, which are as evidence-based as possible[9,10]. The present results, based on mostly implants with a turned surface could be taken as an example of this challenge where introduction of new implant surfaces may have an obvious impact on implant failures[11].

One should be aware that 5- and 10-year survival rates and complication frequencies presented in systematic reviews are commonly calculated through advanced algorithms and statistical methods. They are therefore theoretical assumptions and not observations per se. Since the selected studies forming the base of the present review, report on relatively few patients and show variations in inclusion, type of treated patients, implant systems, performed treatments and follow-ups, it was decided to only calculate an 'overall survival rate'. Therefore the authors refrained from more sophisticated calculations which would imply more accurate data than actually observed.

Inclusion of studies in review publications is based on inclusion criteria and the compliance and interpretation of these criteria during the process. Sometimes the criteria for inclusion may become too strict which results in the inclusion of no or very few studies. Most of the present studies were also included by Jung et al[6]. However, some of the 'long-term/10-year studies' included by them were excluded from the present review. The main reason for this was that the follow-up time was too short as defined in the pre-set inclusion in the present study. Yet, two studies were excluded for other reasons; Brägger et al[12], because there were problems when extracting patient level data, and Jung et al[13], because there were problems in finding detailed information on inclusion criteria and the number of individual patients with single crowns.

The most frequent reason for exclusion in the present review was mixing up data for single crown

restorations with those of other restorations in the partially edentulous jaw, reported in the same study. Sometimes an inconsistency in, for example the number of included patients and implants in earlier publications for the same study group led to the exclusion. The present long-term results are comparable to those reported by Jung et al[6] indicating that about 94 % of the patients (95% of implants) will not experience a failure during follow-up. This observation is re-assuring, indicating that compared to data for 5 years of follow-up[6], no obvious increase in failure rate seems to occur during the last 5 years. However, the present long-term observation is basically based on implant systems with implant surfaces – mostly turned - that are not in use today (Table 1). Future long-term studies based on implant surfaces used today may reveal other survival rates.

Compared to the relatively low levels of implant failures over the years, failure rate of the original crown restoration seems to be higher (11.0 %). This review reveals that a number of crown restorations were remade due to the learning curve associated with a new technique, or due to more time dependent factors, such as fractures, changed shade of adjacent teeth, mucosal recession and implant infraposition after facial growth.(5, 14) Thus, it must be considered that remaking some single crowns is part of the maintenance protocol during the lifetime of the patient.

Conclusions

- Nine publications covering 10 years or more of clinical follow-up of single implant treatment were included in the present study. These studies comprised altogether 421 patients at inclusion and 367 patients at termination of the studies (87%).
- Altogether 25 patients presented an implant failure (25 implants) during follow-up, resulting in an estimated overall patient implant treatment survival rate of 93.8% at termination. Corresponding implant survival on 'implant level' was 95.0%.
- Fifty-three single implant crown restorations were reported to be lost, either as a result of implant failures (20 crowns) or were remade due to various reasons (33 crowns). Original single implant crown survival rate was calculated to be 89.5%.
- Data on mechanical complications were not consistently reported amongst the studies to allow an overview.
- Data on other biological problems were not consistently reported amongst the studies to allow an overview.

List of included studies

- Thilander B, Ödman J, Lekholm U. Orthodontic aspects of the use of oral implants in adolescents: a 10 year follow-up study. Eur J Orthod 2001;23:715–731.
- Jemt T. Single implants in the anterior maxilla after 15 years of follow-up: comparison with central implants in the edentulous maxilla. Int J Prosthodont 2008;21:400–408.
- Jemt T. Cemented CeraOne and porcelain fused to TiAdapt abutment single-implant crown restorations: a 10-year comparative follow-up study. Clin Implant Dent Relat Res 2009;11:303–310.
- Gotfredsen K. A 10-Year prospective study of single tooth implants placed in the anterior maxilla. Clin Implant Dent Relat Res 2012;14:80–87.
- Matarasso S, Rasperini G, Iorio Siciliano V, Salvi GE, Lang NP, Aglietta M. A 10-year retrospective analysis of radiographic bone-level changes of implants supporting single-unit crowns in periodontally compromised vs. periodontally healthy patients. Clin Oral Implants Res 2010;21: 898–903.
- Bonde MJ. Stokholm R, Isidor F, Schou S. Outcome of implant-supported single-tooth replacements performed by dental students. A 10-year clinical and radiographic retrospective study. Eur J Oral Implantol 2010;3:37–46.
- Covani U, Chiappe G, Bosco M, Orlando B, Quaranta A, Barone A. A 10-year evaluation of implants placed in fresh extraction sockets: a prospective cohort study. J Periodontol 2012;83:1226–1234.
- Bergenblock S, Andersson B, Fürst B, Jemt T. Long-term follow-up of CeraOne™ single-

implant restorations: an 18-year follow-up study based on a prospective patient cohort. Clin Implant Dent and Relat Res 2012;14:471–479.

- Misje K, Bjørnland T, Saxegaard E, Jensen JL. Treatment outcome of dental implants in the esthetic zone: a 12- to 15-year retrospective study. Int J Prosthodont 2013;26:365–369.

References

1. Vogel R, Smith-Palmer J, Valentine W. Evaluating the health economic implications and cost-effectiveness of dental implants: a literature review. Int J Oral Maxillofac Implants 2013;28:343–356.
2. Kim Y, Park JY, Park SY, Oh SH, Jung Y, Kim JM, Yoo SY, Kim SK. Economic evaluation of single-tooth replacement: dental implant versus fixed partial denture. Int J Oral Maxillofac Implants 2014;29:600–607.
3. Scheuber S, Hicklin S, Bragger U. Implants versus short-span fixed bridges: survival, complications, patients' benefits. A systematic review on economic aspects. Clin Oral Implants Res 2012;23(Suppl 6):50–62.
4. Jensen SS, Bosshardt DD, Gruber R, Buser D. Long-term stability of contour augmentation in the esthetic zone: histologic and histomorphometric evaluation of 12 human biopsies 14 to 80 months after augmentation. J Periodontol 2014;85:1549–1556.
5. Lewis MB, Klineberg I. Prosthodontic considerations designed to optimize outcomes for single-tooth implants. A review of the literature. Aust Dent J 2011;56:181–192.
6. Jung RE, Zembic A, Pjetursson BE, Zwahlen M, Thoma DS. Systematic review of the survival rate and the incidence of biological, technical, and aesthetic complications of single crowns on implants reported in longitudinal studies with a mean follow-up of 5 years. Clin Oral Implants Res 2012;23 (Suppl 6):2–21.
7. Taylor TD, Agar JR, Vogiatzi T. Implant prosthodontics: current perspective and future directions. Int J Oral Maxillofac Implants 2000;15:66–75.
8. Walther W. On diverse approaches to prosthodontic research: the case series approach to clinical research. Int J Prosthodont 2007;20:374–375.
9. Egger M, Smith GD. Meta-Analysis. Potentials and promise. BMJ 1997;315:1371–1374.
10. Pjetursson BE, Brägger U, Lang NP, Zwahlen M. Comparison of survival and complication rates of tooth-supported fixed dental prostheses (FDPs) and implant-supported FDPs and single crowns (SCs). Clin Oral Implants Res 2007;18 (Suppl 3):97–113.
11. Jemt T, Olsson M, Franke Stenport V. Incidence of First Implant Failure: A Retroprospective Study of 27 Years of Implant Operations at One Specialist Clinic. Clin Implant Dent Relat Res 2015;17(Suppl 2):e501–e510.
12. Brägger U, Karoussis I, Persson R, Pjetursson B, Salvi G, Lang N. Technical and biological complications/failures with single crowns and fixed partial dentures on implants: a 10-year prospective cohort study. Clin Oral Implants Res 2005;16:326–334.
13. Jung RE, Fenner N, Hammerle CH, Zitzmann NU. Long-term outcome of implants placed with guided bone regeneration (GBR) using resorbable and non-resorbable membranes after 12-14 years. Clin Oral Implants Res 2013;24:1065–1073.
14. Andersson B, Bergenblock S, Furst B, Jemt T. Long-term function of single-implant restorations: a 17- to 19-year follow-up study on implant infraposition related to the shape of the face and patients' satisfaction. Clin Implant Dent Relat Res 2013;15:471–480.