**Summary**

**Selection Criteria**

A systematic review of long-term survival rates of dental implants and natural teeth was conducted. The MEDLINE database was searched for relevant publications up to March 2013. The authors included prospective longitudinal studies and retrospective studies published in English with a minimum follow-up period of 15 years. Studies included assessed tooth preservation or the effectiveness of dental implants and reported the outcome in the form of unit survival. At least five cases needed to be reported. Studies not meeting these criteria, in particular with shorter follow-up periods or unclear descriptions of the survival rates over the follow-up period, were excluded.

For the assessment of tooth survival, the initial MEDLINE search returned 2700 results, of which 2614 articles were excluded after title assessment. After abstract evaluation of the remaining 86 articles, 15 articles were retrieved for full-length review, of which 6 were excluded, resulting in a final 9 articles included in quality assessment and full-text review for tooth preservation. The initial search for long-term implant survival returned 2243 studies, of which 2194 articles were excluded, and 49 abstracts reviewed. Out of these 49, 14 studies were obtained for full-length review. Of these 14 articles, 4 were excluded, leaving 10 articles for quality assessment and review for the long-term survival of dental implants. For both bodies of literature a manual search of the bibliographies of published review articles and the selected studies was conducted to find additionally relevant reports. The authors resolved disagreements by discussion.

The following data were extracted from the selected studies: author or authors; year of publication; follow-up period; number of patients; mean age and age range of patients; periodontal disease classification; number of teeth or implants at baseline and follow-up; implant system; type of prostheses (single crown, fixed partial denture, complete denture); SPT; tooth or implant survival rate; number of patients exhibiting tooth or implant loss; reasons for tooth or implant loss; and timing regarding implant loss. A risk of bias assessment was carried out using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. One of the PRISMA criterions (concealment of the allocation sequence) was excluded as not being relevant to this systematic review. One additional criterion was added evaluating whether external funding was provided for the study.

**Key Study Factor**

Key study factors were the preservation of natural teeth or the placement of dental implants.

**Main Outcome Measure**

The primary outcome measure was the long-term survival rate of teeth and implants.
Main Results
The investigators selected a total of 19 articles for inclusion, of which 9 studies assessed tooth survival rates and 10 studies implant survival rates. Due to the substantial heterogeneity of the selected studies a meta-analysis of the data could not be performed. A comparison of the long-term survival rates, here over 15 years of follow-up, revealed a range between 86.6% and 96.4% for teeth and 77% and 100% for implants.

The follow-up periods for tooth-related studies ranged from 16 to 30 years. Tooth loss from baseline to the examination point varied between 3.6% and 13.4%. If active periodontal treatment was rendered, between 1.4 and 3.6 teeth per patient were lost. A similar range was observed for supportive periodontal treatment only, with tooth loss ranging from 3.8% to 11.3% and 0.92 to 2.6 teeth lost per patient after 16 to 22 years of follow-up. Loss rates for questionable teeth were between 11.3% and 31.1%, with higher tooth loss rates for teeth classified as hopeless. However, the overall tooth loss rate and the tooth loss rate for compromised teeth (based on the initial prognosis) were not affected by aggressive periodontal disease when the teeth were properly treated and maintained.

Follow-up periods for implant studies ranged from 15 to 23 years. Besides the general survival of implant units, the authors of the systematic review included marginal bone loss in the observation. Reported bone loss varied between 0.05 and 2.1 mm for the included studies. The investigators compared these data to a study reporting on shorter follow-up periods of up to 10 years and found implant loss ranging from 1% to 18% and marginal bone loss of 0.7–1.3 mm. It was suggested that this might imply a greater bone and implant loss over longer follow-up periods. The authors also remarked that, although ample evidence exists in the literature, several factors such as different implant types, implant surface texture, implantation in augmented bone, peri-implant disease, other biological and mechanical complications, and patient-related factors including smoking, diabetes mellitus, or history of periodontal disease, were not sufficiently addressed by the 10 implant studies selected for data comparison. Long-term studies that assess the influence of these factors are still not available.

The risk-of-bias assessment of the included studies resulted in the overall finding that studies dealing with dental implants tended to present a higher risk of bias, in particular because of direct or indirect financial support by the dental implant industry, which was not always disclosed.

Conclusions
Treatment planning should involve the long-term probability of success for any chosen treatment modality. Based on this systematic review, the authors concluded that the decision to preserve properly treated and maintained teeth for as long as possible may be an overall solution that can reduce treatment risks over a long-term period before replacing a tooth with an implant.

COMMENTS AND ANALYSIS
This systematic review assessed data from research studies investigating the long-term outcome of natural teeth and dental implants. The authors identified the lack of reliable long-term data for endosseous dental implants.

The question raised was whether extraction of a natural tooth with subsequent placement of an implant in young adults was validated by the long-term success of implants. A natural tooth could always be extracted and replaced at a later time, whereas the removal of an implant with secondary replacement was reported to have lower success rates.

The strength of this article is the extraction of valuable data from very long-term follow-up studies (>15 years). The authors decided against a meta-analysis, because the 19 selected studies were very heterogenous. Prospective, retrospective, and longitudinal studies were included. Also, the individual studies on tooth or implant retention differed greatly in study design and investigated disease/subjects.

Nevertheless, this is still a well-conducted review. The lack of a meta-analysis may weaken the strength of evidence; however, it must be made clear that for most dental subjects a systematic review of data ranging 15–30 years back in time would be confronted with the same problems. Studies designed 20–30 years in the past did not necessarily adhere to the same strict criteria of evidence-based dentistry, as, for example, with well-defined study designs put forward by CONSORT trial guidelines. Moreover, there are inherent difficulties involved with any long-term study exceeding 10 years, including individual patient follow-up and general recall rates, thus leaving the fate of many un-recalled units in question.

The authors correctly identified problems with the selected studies in regard to the comparison between teeth and implants. Studies on teeth often followed an epidemiologic approach, while many implant studies were particularly designed to investigate individual implant systems, were carried out in university settings, and included a selected, more homogenous patient population lacking individual risk factors. Many studies on teeth investigated periodontal disease. In clinical practice, however, many teeth that are being replaced by dental implants are extracted for restorative reasons and not periodontal problems. Therefore the studies included in this systematic review may not provide an ability for adequate comparison.

The authors correctly concluded that a consensus for the classification of tooth prognosis is missing and that practitioners need this for an evidence-based decision. Similarly, implant dentistry is missing a consensus on criteria for
implant success; survival is mostly used instead. Marginal bone loss was added by the authors to their data extraction from the implant studies. Together with the survival rates, this was compared to a 10-year follow-up study of implants. It was concluded that implant and bone loss were progressively increasing over time. After review of the 10 long-term implant studies it was noted that factors affecting implant survival rates, such as smoking, diabetes mellitus, history of periodontal disease, and the influence of placing implants in augmented bone were not addressed in these studies. The authors extensively supported the negative influence of these factors by citing additional short-term studies. An emphasis was placed on the fact that long-term implant survival may be further affected by the comorbidity of factors such as smoking or implant placement in augmented bone and that this may not be obvious from studies with a rather select patient population. However, it was also correctly remarked that implant systems and techniques have improved over time. Nevertheless, it has not been shown as of today whether this will also result in an increase in implant survival.

A recent 20-year follow-up on rough surface implants in partially edentulous patients that was published after the cut-off date of this study found a survival rate of 89.5% and further validates the data from this systematic review. Any compromised tooth, dental implant, or their respective permanent restoration has a limited life span. The data provided in this systematic review are in alignment and further strengthen the findings that implants do not exceed the life expectancy of natural teeth at 10 years, respectively, over an even longer period of time, including endodontically treated or periodontally compromised teeth and that the loss rate of teeth is lower than that of dental implants in patients who are clinically well-maintained.

Overall, this systemic review provides valuable information on the long-term fate of teeth and implants. Since a meta-analysis was not feasible, the study does not present the highest level of evidence, but does offer difficult-to-obtain best available evidence at this point in time.

REFERENCES


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