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What are the longevities of teeth and oral implants?

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Key words: endodontically treated, longevity, oral implants, periodontally compromized, survival, tooth loss

Abstract

Objective: To analyse tooth loss and to evaluate the longevity of healthy teeth and teeth compromised by diseases and influenced by therapy as well as that of oral implants.

Material and methods: On the basis of an electronic and manual search using key words for survival, success, longevity of teeth, longevity of implants, epidemiology, periodontally compromised, endodontically compromised, risk for tooth extraction 49 full-text articles were identified to construct a traditional review. Among these, six systematic reviews addressing longevity were found.

Results: Tooth loss is a complex outcome, it is influenced by the extent of dental caries and its sequelae and/or the presence or absence of periodontitis as well as the decisions taken by dentists when evaluating possible risk factors for rendering successful therapy. In addition, tooth loss is related to behavioural and socio-economic factors and associated morbidity and cultural priorities. Generally, teeth surrounded by healthy periodontal tissues yield a very high longevity (up to 99.5% over 50 years). If periodontally compromised, but treated and maintained regularly, the survival of such teeth is still very high (92–93%). Likewise, endodontically compromised, but successfully treated devital teeth yield high survival and success rates. The survival of oral implants after 10 years varies between 82% and 94%.

Conclusions: Teeth will last for life, unless they are affected by oral diseases or service interventions. Many retained teeth thus may be an indicator of positive oral health behaviour throughout the life course. Tooth longevity is largely dependent on the health status of the periodontium, the pulp or periapical region and the extent of reconstructions. Multiple risks lead to a critical appraisal of the value of a tooth. Oral implants when evaluated after 10 years of service do not surpass the longevity of even compromised but successfully treated natural teeth.

In the beginning of the 20th century extraction of teeth and their replacement with dentures were perceived as an acceptable – and perhaps even preferable – approach to treating substantial dental problems, especially for those of limited means and socioeconomic status. Consequently, tooth loss and edentulism were common among older people just a few decades ago. However, several recent studies have yielded a significant decline in edentulism and tooth loss in adult and older populations as well as among subcategories of elderly persons such as the oldest old (e.g., Petersen & Yamamoto 2005; Vilstrup et al. 2007; Müller & Carlsson 2007).

Tooth loss reflects the ultimate outcome of oral disease over the course of life.

To cite this article:
Holm-Pedersen P, Lang NP, Müller F. What are the longevities of teeth and oral implants?
Clin. Oral Impl. Res. **18** (Suppl. 3), 2007; 15–19
doi: 10.1111/j.1600-0501.2007.01434.x

However, tooth removal practices vary greatly among various societies. The decision to extract teeth is not only influenced by the extent of caries and its sequelae and/or periodontal disease, but is also based on the value placed on tooth retention by dentists and patients and the patients' ability to pay for dental treatments. This suggests that tooth loss may also be related to complex behavioural and socio-economic factors (Joshipura & Ritchie 2005).

Several studies have found that people in low socio-economic groups have fewer teeth than those in higher socio-economic groups (e.g., Hanson et al. 1994; Avlund et al. 2003; Krustrup 2004; Petersen et al. 2004; Krustrup et al. 2007). In a longitudinal Swedish study, Cabrera et al. (2005) recently reported that tooth loss was associated with mortality. However, the association between tooth loss and future mortality could not be explained by socio-economic factors. In contrast, another longitudinal study from Florida found that race and socio-economic status (SES) were strong determinants of tooth loss (Gilbert et al. 2003). In the first stage of their analysis, different degrees of oral disease severity and new symptoms explained the disparities in tooth loss, with no contribution from socio-economic differences in attitudes towards tooth loss and dental care. However, when they analysed their data to take account of disparities in dental care use between groups, social disparities in tooth loss that were not directly due to oral diseases became evident. They hypothesised that individuals from lower socio-economic groups were more likely to receive dental extractions once they entered the dental care system, given the same extent and severity of disease. These findings underscore that if disparities in dental care use are not taken into account, the effect of socio-economic status on tooth loss, and perhaps on associated morbidity, is artificially minimised.

Teeth are lost for many reasons. In addition to socio-economic factors, several predictors of tooth loss have been identified, including age and components of lifestyle such as smoking and alcohol consumption (Worthington et al. 1999; Copeland et al. 2004; Klein et al. 2004) as well as marital status (Locker et al. 1996; Worthington et al. 1999). Predictors vary by population and gender (Copeland et al. 2004). Moreover, tooth loss is a complex outcome, as it depends predominantly on decisions taken by dentists and patients (Locker et al. 1996).

Although teeth in adolescents and young-adults might have been lost primarily because of dental caries, several studies suggest that tooth loss later in life may be due primarily to the sequelae of periodontal infections (Desvarieux et al. 2003; Elter et al. 2003; Schürch & Lang 2004). Periodontal attachment loss has been identified as a significant risk factor for tooth loss (e.g., Warren et al. 2002; Gilbert et al. 2005). Reich & Hiller (1993) found that periodontal disease was the most frequent cause of tooth extraction for people over the age of 40 years, while for those below the age of 40 years, dental caries and third molar extractions were the most frequent reasons. In contrast, Fure & Zickert (1997) found that the major reason for tooth extraction in 60-, 70-, and 80-year olds was still dental caries. Also, identified in a retrospective cohort study in American veterans, the reason for tooth extractions were attributed to dental decay in over 60%, while periodontal reasons were documented for only 33% of the extractions (Niessen & Weyant 1989). Similar results were recently reported in patients attending dental practices in South Wales (Richards et al. 2005). The reasons for extractions of teeth in that study were approximately 60% for dental caries, approximately 30% for periodontal disease, and the remaining for other reasons. Schätzle et al. (2004) found that teeth consistently surrounded by severe gingival inflammation over a 26-year observation period were at significantly higher risk to be lost compared with teeth surrounded by inflammation-free gingiva confirming the role of gingival inflammation as a strong risk factor for tooth loss.

The aim of this review is to evalute the longevity of teeth of various conditions and compare it with that reported for oral implants.

Material and methods

On the basis of electronic (Pub-Med) and manual searches using key words for survival, success, longevity of teeth, longevity of implants, epidemiology, periodontally compromised, endodontically compromised, risk for tooth extraction, 49 full-text articles were identified to construct a traditional review. Among these, six systematic reviews addressing longevity were found.

Results

The tooth

The study by Schätzle et al. (2004) further showed that 412 out of 487 urban middle class Norwegian males who had been exposed to a prevention-oriented dental care system from age three did not loose any teeth over a 26-year observation period. The remaining 75 re-examined subjects had lost 126 teeth: 49 subjects lost one tooth, 12 subjects lost two teeth, eight subjects lost three teeth, three subjects lost four teeth, two subjects lost five teeth, and one subject lost 7 teeth. Most of the teeth extracted were molars. Logistic regression analysis showed that teeth consistently surrounded by severe gingival inflammation had a 45-fold increased risk of extraction compared with those teeth always surrounded by healthy gingiva. The results showed that tooth loss is a rare phenomenon in this population with regular and preventively oriented oral heath care. It was concluded that the tooth survival rates observed in this study surpass those for oral implants (Schätzle et al. 2004). Higher tooth mortality rates have been reported in patients treated for periodontitis (McGuire & Nunn 1996).

Periodontally compromised tooth

Schätzle et al. (2004) evaluated generally periodontally healthy teeth from a middle class Norwegian male population and showed tooth survival after 50 years of function ranged from 99.5% for teeth without gingival inflammation to 94% for teeth with occasional inflammation and 64% for teeth with a continuous bleeding on probing at all observation periods. There are no longitudinal studies that have assessed the survival of the periodontally compromised dentition, in part due to ethical problems of observing the progression of untreated disease. Hence, the longevity of the periodontally compromised tooth has to be evaluated on the basis of cohort studies performed to assess the efficacy of periodontal therapy. Routine periodontal therapy involving motivation and instruction of the patient in oral hygiene procedures, scaling, and root planing under local anaesthesia and – if residual pockets persisted after a re-evaluation – the performance of access flap surgery yielded predictable outcomes and long-term stability of treatment results (Tonetti et al. 2000). During the course of up to 22 years of treated and well-maintained periodontal patients, 0.23 compromised teeth were lost per patient per year, i.e. one tooth was lost every 5 years in this population treated for advanced periodontitis. The teeth lost were predominantly molar teeth (Tonetti et al. 2000).

Two groups of authors have assessed the survival of furcation-involved maxillary molars following root section and amputation with a mean observation period of 10 years. One group presented survival rates of approximately 92–93% (Basten et al. 1996; Carnevale et al. 1998; Svärdström & Wennström 2000), while the second group presented 10-year survival of only 62–68% after resections in severely compromised molars with Class III furcation involvement (Langer et al. 1981; Bühler 1988). It is evident that the latter group lost a lot of teeth due to tooth fractures following endodontic therapy.

Eickholz et al demonstrated 100% survival 5 years after regenerative (GTR) therapy in Class II furcation involved mandibular molars (Eickholz et al. 2001). Likewise, the treatment of Class I furcation involved teeth had a 100% survival after 5 years (Hamp et al. 1975).

In summary, the treatment outcomes for periodontally compromised molar teeth with furcation involvement showed in most instances over 90% survival after 10 years. If such teeth are additionally jeopardized by having been endodontically treated, the survival rate may be lower.

Another recent systematic review (Lulic et al. 2007) evaluated the survival of periodontally treated abutment teeth supporting full arch bridgework with only few abutments and hence, not following Ante's law (1926). Based on three studies from the same group of academic practitioners, the 10-year survival was as high as 92.9%. This clearly indicates that the periodontally compromised tooth successfully treated and maintained at regular intervals has a very high longevity.

Endodontally treated tooth

A study at the University of Oslo of the periapical and clinical status of crowned teeth over an observation period of 17–25 years found that the incidence of periapical lesions in crowned teeth with a vital pulp was very low (Valderhaug et al. 1997). The results showed that the survival rates of restored teeth with a vital pulp and of root-filled teeth were similar. In that study the main reasons for tooth complications were caries (12%) and for teeth with a vital pulp loss of vitality (10%). However, a high proportion of crowned teeth with a vital pulp remained free of signs of pulpal deterioration over the 25 year observation period.

Similar aspects resulted from a study at the University of Glasgow and Dundee Dental Hospitals where full-mouth periapical radiographs of 319 consecutively admitted patients (7596 teeth) were examined (Saunders & Saunders 1998). Two hundred and two patients had at least one tooth that was crowned. A total of 802 crowned teeth were evaluated. Four hundred and fifty-eight were vital at the time of incorportion of the crown and 19% ($n = 87$) of these had radiographic signs of periapical pathology. This indicates the high risk for loosing vitality following tooth preparation.

In a recent retrospective radiographic study at the University of Bergen, the periapical conditions of 265 roots were evaluated 10–17 and 20–27 years after root canal treatment (Molven et al. 2002). The total failure frequency after 20–27 years was 4.9%, while 86.4% had completely normal periapical conditions at the follow-up. A few roots that showed radiolucencies after 10–17 years had normal periapical conditions after 20–27 years indicating that late healing may occur. The majority of these roots had overextended root fillings. These findings were confirmed and extended by a subsequent study of 112 roots that had been retreated with root fillings 20–27 years earlier (Fristad et al. 2004). The percentage of roots with normal periapical conditions were 95.5%. A total of 28 retreated roots had been lost during the 20–27 year period. The results showed a better success rate after 20–27 years than after 10–17 years suggesting that persisting periapical translucencies may, indeed, be reduced after a long period of time.

In a review of the literature, Heling et al. (2002) concluded that prompt placement of coronal restorations improve the prognosis of root canal-treated teeth by sealing the canal and minimising the leakage of oral fluids into the periapical area. A retrospective study of factors associated with the periapical status of restored, endodontically treated teeth concluded that a good quality of the root filling and crown margins improve the prognosis of endodontic therapy (Iqbal et al. 2003).

In a meta-analysis, Basmadjian-Charles et al. (2002) found that there was agreement between studies that two major factors, preoperative periapical status and the apical limit of the root filling, strongly influence the long-term success of endodontic therapy. In another recent meta-analysis of 19 studies with follow-up periods from 6 months to 17 years, Kojima et al. (2004) found that the cumulative success rate was 82.2% for vital pulps and 78.9% for nonviable pulps. There was a significant difference between flush and overextension of the root canal filling and between flush and underextension of the root canal filling, success rate 70.8% (overextended) vs. 86.5% (underextended), respectively. It was concluded that the root canal should be filled to within 2 mm of the radiographic apex.

The Toronto study had an observation period of between 4 and 6 years (Farzaneh et al. 2004; Marquis et al. 2006). Initial root canal treatment showed that 85% of apical lesions resolved overall with 93% resolution for teeth without and 79% for teeth with periapical pathology at the time of therapy. The odds ratio for healing was 3.3 [95% confidence interval (CI) 1.4–8.1] when periapical pathology was absent. Also for retreated roots, the healing proportions were 97% and 78% for teeth without and with periapical pathology, respectively, while the mean was at 81%. The presence of perforations reduced the success rates to 42% as opposed to 89% without perforations resulting in an odds ratio of 26.5. Summarizing the success of endodontically treated teeth, it may be stated that primary as well as retreated roots have a high success and survival rate, generally over 90% after 10 years. However, existing periapical pathology may dramatically decrease the survival of non-vital teeth to less than 80% after 5 years. The highest risk for tooth loss appears to be the presence of perforations during retreatment decreasing the 5-year survival to as low as 42% (Farzaneh et al. 2004; Marquis et al. 2006).

Oral implant

Survival of oral implants has been systematically analysed in the 4th European Workshop on Periodontology in 2002 (Berglundh et al. 2002). From 1310 titles and abstracts, 159 full-text articles finally lead to the selection of 51 papers for meta-analysis. It is evident that the survival of oral implants before loading (healing and incorporation) is very high. However, an initial loss of 2.5% of all implants is to be expected in routine implant therapy. After functional loading the implant loss was 2–3% over an observation period of 5 years for implants supporting fixed bridgework, while in overdenture therapy >5% of the implants can be expected to be lost within a 5-year period.

Recently, five systematic reviews (Lang et al. 2004; Pjetursson et al. 2004a, 2004b; Tan et al. 2004; Jung et al. 2007) have been presented addressing longevity of fixed dental prosthesis on either natural teeth or oral implants after 5 and 10 years and implant supported single crowns. In this respect, the survival rates of implants after 5 years were 96.5%, 95.4% and 90.1% for single crown implant (SC) reconstruction (Jung et al. 2007), implant–implant (I–I) reconstructions (Pjetursson et al. 2004a) and the implant–tooth (I–T) reconstructions (Lang et al. 2004), respectively. Thus, the estimated annual failure rates after functional loading were 0.64%, 0.51%, and 1.3%, respectively. Consequently, the survival rates after 10 years were 96.3%, 92.8%, and 82.1% for single implant crowns, I–I and the I–T reconstructions, respectively. In agreement with Berglundh et al. (2002) the failure rates before functional loading were 1.9%, 2.5% ,and 2.7% for the three groups (SC, I–I and I–T).

Summarizing the survival rates of oral implants after 5 and 10 years it has to be stated that 2.5% of all implants are lost before loading. In addition, between 0.5% and 1.3% are lost per year of function resulting in survival rates after 10 years that are between 80% and 90% depending on the clinical situation of implants serving as abutments for I–I- or T–I-borne reconstructions. In no way does the longevity of oral implants surpass that of natural teeth even of those that are compromised for either periodontal or endodontic reasons.

It has to be realised that the survival and success rates reported for most of the studies include well-maintained patients under regular supportive care.

Discussion

To maintain or to extract – strategic importance of the tooth?

From the literature screened and the numerous systematic reviews quoted in this traditional review it is evident that tooth longevity surpasses implant longevity after 10 years of observation. The reasons for tooth loss are rarely attributable to a single risk for either periodontal or endodontic aspects. Rather, dentists seem to make the decision for extracting a tooth on the basis of multiple risk factors including remaining tooth structure, extent of previous reconstructions, build-ups with post and core as well as strategic importance of a tooth within the dentition in balance with periodontal and endodontic aspects. While single identifiable risks may be easy to cope with clinically, the presence of multiple risks appears to jeopardise the survival of a compromised tooth. Nevertheless, even the survival of such teeth seems to surpass that of oral implants if the implant loss before loading is added to that during function over 10 years.

Conclusions

Teeth will last for life, unless they are affected by oral diseases or service interventions. Many retained teeth thus may be an indicator of positive oral health behaviour throughout the life course. Tooth longevity is largely dependent on the health status of the periodontium, the pulp or periapical region and the extent of reconstructions. Multiple risks lead to a critical appraisal of the value of a tooth. Oral implants when evaluated after 10 years of service present with a longevity that does not surpass that of even compromised, but successfully treated and maintained teeth.

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