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Survival of Restored Endodontically Treated Teeth in Relation to Periodontal Status

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The aim of the present study was to investigate the success and survival of restored endodontically treated teeth (ETT) in a general practice environment related to periodontal parameters. Data from 360 restored ETT treated between 2000 and 2011 were collected. Dates of interventions like restorations, repairs, replacements and extractions were recorded. Additionally, general information about patients and dentitions as well as periodontal status was recorded. Success was analyzed using Kaplan-Meier statistics and a multivariate Cox regression analysis was performed to assess variables influencing success and survival. After a mean observation time of 4.34 years (range 0.6 - 11.6 years), 19 teeth were extracted and 27 restorations needed repair or replacement. According to the Cox regression, increasing maximum pocket depth of the tooth resulted in a higher risk for failure (p=0.012). In conclusion, periodontal pocket depth was found to be a significant factor in the survival of restored ETT.

Key Words: longevity, dental restoration, retrospective study, endodontic treatment, periodontal status.

Introduction

Endodontic treatment has been evaluated at several different levels, starting at the success of the treatment itself in preventing or curing periapical lesions (1), through the level of success of restoring to function endodontically treated teeth (ETT) (2), and finally at the level of long-term survival of ETT (3). Slowly but surely, it is becoming clear that factors beyond the quality of endodontic treatment may be relatively important in determining long-term outcomes. For instance, the quality of the coronal restoration was shown to be more important in endodontic treatment success than the quality of the endodontic filling (4). When looking at the reasons for extraction of ETT, endodontic failure represents often only a small part of total failure, with non-restorable breakdown & caries (5), root fracture (6), or periodontal disease (7) reported as the main failure reasons.

Increasingly, factors at the level of complete dentition or complete patient are being included in studies of success and survival of ETT. In a recent study report by this group on a retrospective study on 795 teeth in 458 patients in a private practice, it was shown that dentition related factors, like number of teeth in the dentition and being the last tooth in the arch, might play an important role (3).

It is a commonly accepted principle in dentistry that tooth prognosis is taken into account before indicating extensive and possibly expensive treatments, like an endodontic treatment. An aspect often included in determining prognosis is the periodontal status of the tooth, usually the attachment loss (8). The effect of endodontic treatment on the success of subsequent periodontal treatment has been studied (9). However, there is very limited scientific evidence for the effect of periodontal status on the outcome of endodontic treatment (10) and survival of restored ETT.

In a recent report on 1175 ETT in 411 patients, where most of the patients were advanced periodontal cases rehabilitated with fixed prostheses, the 10-year survival rate was high: 93% and the most common reason for extraction was recurrent periodontal disease (43%) (11). A few cross-sectional studies are available where both periodontal status and endodontic status were evaluated. One study showed slightly more attachment loss (0.6 mm) in ETT than in contralateral untreated controls (12). However, this may have been due to the ETT being restored with crowns, among which 75% were judged defective. In a more recent study evaluating 50 molar teeth restored with crowns, the occurrence of negative events, apart from extractions also including retreatments, was found to be related to attachment loss of the tooth and "prognostic value" (13).

As so little evidence is available on the effect of periodontal status on the survival of ETT, an additional analysis was performed on a subset of a retrospective study, selecting those teeth/patients for which periodontal status and treatment information was available. The aim of the present retrospective clinical study, therefore, was to investigate the success and survival of ETT in a general practice environment related to periodontal parameters.

Material and Methods

The present study is a non-intervention clinical trial without need for local review board approval, according to European guidelines for good clinical practice (CPMP/ICH/135/95). A previous report describes the parent data set and the recorded variables for the current study (3). In brief: digital files from a German private practice were used for collecting data for this practice-based survival study. Inclusion criteria were patients that had a root canal treatment and subsequent restoration (composite resin or crowns). Patients should be loyal to the practice, and ETT with a minimal observation time of 6 months were included. From the parent data set of 458 patients (795 ETT), 158 (93 female and 65 male) fulfilled the additional inclusion criterion of periodontal status and treatment data being available, corresponding to 360 ETT.

From the patient records, dates of endodontic and restorative procedures, date and type of intervention (repairs/replacement/extractions) and dates of periodontal treatments or periodontal check up were collected. The last visit was considered as the censoring date for restorations and tooth still *in situ*. The following periodontal characteristics were collected from the patient files:

-Maximum pocket depth of tooth: Pockets were measured before endodontic treatment at six sites, and the highest value of the 6 measurements was recorded as maximum pocket depth of the tooth.

-Average of maximum pocket depth of dentition: An average of maximum pocket depths of all teeth (as described above) was calculated.

Statistical analyses were performed with SPSS 20 (SPSS Inc., Chicago IL, USA) and R (v. 3.0.2: R. Foundation for Statistical Computing, Vienna, Austria). For the outcome success, failure was defined as an ETT needing repair, a

Table 1 Cox regression model Extension of starting model with “Pocket depth of tooth treated”

(Last Step) Variable	p-Value	Hazard ratio	95% Confidence Interval	
			Lower	Upper
Success				
Pocket depth of tooth	069	106	079	143
Number of teeth in the dentition	0004	092	087	097
Premolars (reference=Incisor)	071	084	033	213
Molars (reference=Incisor)	010	225	085	594
Decayed teeth	002	084	072	097
Survival				
Pocket depth of tooth	0012	160	111	230
Number of teeth in the dentition	<0001	088	084	094

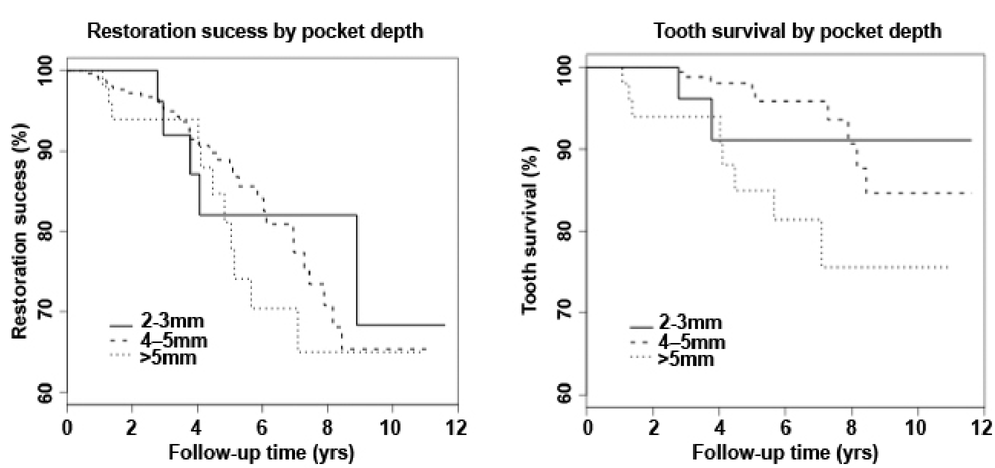

Figure 1. Kaplan-Meier for ETT success (A) and survival (B) by maximum pocket depth of the tooth.

new restoration or extraction. For the outcome survival, failure was defined as an ETT being extracted. The influence of variables on success/survival was analyzed using Cox-regression with a Gamma distributed frailty term to model for the clustering of multiple ETT in one patient. As a starting point for the Cox model, the final model from the parent dataset was used (3). For this model, the best extension with additional periodontal information was evaluated. For visualization of the effect of the periodontal variable, Kaplan-Meier curves were constructed for both success and survival.

Results

The patients (mean age 44.3 years, SD 12.5) included in this study had on average 25.9 teeth in their dentition. The maximum pocket depth of the evaluated tooth ranged from 2 to 10 mm. Average maximum pocket depth of the dentition ranged from 2.5 to 6.5 mm.

After a mean observation time of 4.34 years (range 0.6 - 11.6 years), 19 teeth were extracted and 27 restorations needed repair or replacement. This involved 5 old crowns, 21 composites and 22 new crowns. The annual failure rates (AFR) for success of restorations and survival of teeth are not reported here as they have been more extensively reported on in the parent study (3).

Due to the reduced sample size, with reduced number of events (48 for success and 19 for survival), the Cox regression models could include a maximum of 5 and 2 factors for success and survival, respectively. Therefore, in the first model, the factor with the highest p-value was omitted (presence of a post, $p>0.1$). In the second model, combinations of variables from the original models with the periodontal variables were explored.

The addition of "maximum pocket depth of tooth treated" to the model showed to be the best extension of the starting models. Adding the average maximum pocket depth of the patient to this extended model was not a statistically significant improvement of either model. In Table 1, the most extended models are presented for both success and survival. For tooth survival, the number of teeth in the dentition functioned as a protection factor while an increasing maximum pocket depth represented a higher failure risk ($p<0.05$) (Table 1).

For a better visualization of the influence of pocket depth on success and survival of ETT, a classification was made. Three groups were created: 2-3 mm, 4-5 mm and >5mm of pocket depth. Kaplan-Meier survival curves were made for these groups (Fig. 1).

Discussion

This practice-based study evaluated the survival and success of ETT originating from a single dental practice and a single operator. The outcome of this kind of practice-based studies must to be interpreted with care and appropriate statistics should be applied, like the backward stepwise Cox regression that enables to do a multi-variate analysis, and consequently analyze the risk factor of variables.

Of the additional periodontal variables included in this study, only maximum pocket depth of the treated tooth was considered a significant factor in tooth survival. This is in accordance with the study of Setzer (13), where the need for retreatment or extraction was associated with pre-operative attachment loss of the tooth. The size of the effect, as may be seen by the divergence of the Kaplan-Meier curves, is substantial. The calculated hazard ratio of 1.60 indicates that every extra mm of maximum pocket depth increases the risk of failure of the restored ETT by 60%. Moreover, extra care is required in periodontitis patients with ETT due to the high probability of more bone loss compared to untreated teeth (14).

Separately, pocket probing depth and ETT teeth were shown to be factors that can affect tooth survival (15). However, in the present study, it was shown that periodontal disease in ETT could act as an extra risk factor. Overall periodontal status of the dentition as expressed by average pocket depth was not a significant factor, indicating that periodontal disease probably acts more as a tooth-related risk factor, rather than a general dental health related factor. The present results confirm the importance of periodontal status of the tooth in the survival of ETT teeth, outstripping more commonly reported factors such as crown or post placement.

Deeper pocket also increases the crown length, hence increasing stress concentration, which may explain its influence on tooth survival (16). On the other hand, as also demonstrated in the previous study, a greater number of teeth in the dentition acts as a protection factor, possibly because it may be viewed as an overall dental health indicator.

In conclusion, periodontal pocket depth was found to be a significant factor in the survival of restored ETT teeth.

Resumo

O objetivo do presente estudo foi investigar a taxa de sucesso e de sobrevivência de dentes restaurados e tratados endodonticamente (DTE) em uma clínica privada e relacionar com índices periodontais. Dados de 360 restaurações realizadas em DTE realizadas entre 2000 e 2011 foram coletados. As datas das intervenções, como restaurações, reparos, substituições e extrações foram registradas. Ainda, informações gerais relacionadas aos pacientes, aos dentes envolvidos e ao estado periodontal foram também coletadas. A taxa de sucesso foi analisada utilizando o método estatístico Kaplan-Meier e uma análise multivariada do tipo regressão de Cox foi realizada para avaliar variáveis que influenciaram na taxa de sucesso e de sobrevivência. Depois de um período de observação médio de 4,34 anos (0,6-11,6 anos), 19 dentes foram extraídos e 27 restaurações precisaram de reparo ou substituição. De acordo com a regressão de Cox, o aumento na profundidade de bolsa

periodontal do dente resulta em um maior risco de falha (p=0,012). Em conclusão, a profundidade de bolsa periodontal foi considerada como um fator significativo na sobrevivência de dentes restaurados e tratados endodonticamente.

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