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Influence of repeat surgery on treatment time in the interdisciplinary management of impacted maxillary canines: A retrospective cohort study

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ABSTRACT

Purpose: To evaluate the effect of repeat surgery on treatment time in the interdisciplinary management of impacted maxillary canines.
Material and methods: This retrospective cohort study enrolled patients referred for computed tomographic examination for impacted maxillary canines within a 5-year observational period. The occurrence of repeat surgery was analysed with regard to treatment time, canine location, and surgical exposure technique.
Results: A total of 55 patients with 79 impacted maxillary canines were analysed. Of those, 83.6% did not present with complications that would have prompted repeat surgery during their treatment. For patients requiring repeat surgery, time until clinically visible movement of the canine was significantly longer ($p < 0.001$), whereas time between initial movement and eruption into the oral cavity was significantly shorter ($p < 0.001$). Overall treatment time did not differ significantly ($p = 0.13$). An open surgical exposure technique was associated with a significantly lower occurrence of repeat surgeries ($p = 0.03$). Bilateral impaction of canines significantly prolonged overall treatment time ($p = 0.01$).
Conclusions: In the event of initial treatment failure during the interdisciplinary management of impacted maxillary canines, repeat surgery should be considered, which has limited effect on overall treatment time. An open surgical exposure technique is preferable.

1. Introduction

Natural eruption of maxillary canines occurs between the age of 10 and 12 years (Bishara, 1992; Ericson and Kurol, 1988). Failure to erupt and an ensuing impaction occurs more commonly than with other teeth, and may result in root resorption of adjacent teeth, cyst formation, loss of dental arch length, midline deviation, and ankylosis (Ericson and Kurol, 1988; Bishara, 1992; Rimes et al., 1997; Ericson and Kurol, 2000; Alqerban et al., 2011, Sajnani and King, 2012; Strbac et al., 2013).

If diagnosed early, spontaneous eruption of impaction-prone canines can sometimes be facilitated by interceptive treatment, such as early extraction of the deciduous canines and orthodontic space opening (Baccetti et al., 2008). Otherwise, a more complex treatment protocol has to be pursued, requiring the interdisciplinary, surgical, and orthodontic management of such cases (Grover and Lorton, 1985; Al-Nimri and Bsoul, 2011; Sajnani and King, 2012). Accurate diagnostics (Haney et al., 2010; Tymofiyeva et al., 2010; Al-Nimri and Bsoul, 2011; Shewinvanakitkul et al., 2011; Hanke et al., 2012), an appropriate surgical uncovering technique (Kokich and Mathews, 1993; Kokich, 2004), and the correct application of orthodontic forces (Bedoya and Park, 2009; Nieri et al., 2010) are important to ensure a successful treatment outcome.

The literature shows that treatment of patients with impacted maxillary canines is more difficult and time-consuming than that of the average orthodontic patient (Stewart et al., 2001). This may well be due to a number of unique complications that can arise during

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such treatment, such as debonding of the orthodontic attachment, immobility of the impacted canine, gingival ingrowth, or invasive cervical root resorptions. If treatment is disrupted for one of these reasons, repeat surgery is often required (Zuccati et al., 2006; Becker et al., 2010; Sajnani and King, 2012). While additional costs and patient dissatisfaction are known consequences, it is not known whether prolonged treatment time is associated with repeat surgery.

Thus the aim of this study was to evaluate the effect of repeat surgery on treatment time in the interdisciplinary management of impacted maxillary canines.

2. Material and methods

This retrospective cohort study was independently reviewed and approved by the Ethics Committee of the Medical University of Vienna, Austria (EK1093/2011). The study enrolled all patients who had been referred for three-dimensional computed tomography (CT) examination for unilaterally or bilaterally impacted maxillary canines within an observation period of 5 years (2005–2010) and subsequently received interdisciplinary surgical and orthodontic treatment at the University Clinic of Dentistry, Medical University of Vienna, Austria. Inclusion criteria required patients to be at least 10 years of age. Canines were considered to be impacted if they were completely covered by the oral mucosa, either centrally, buccally, or palatally displaced within the alveolar bone, and if natural eruption could not be assumed (Bishara, 1992; Mazinis et al., 2012) or facilitated by interceptive therapy (Ericson and Kurol, 1988; Baccetti et al., 2008, 2009; Alessandri Bonetti et al., 2011).

The primary outcome variable was total treatment time for alignment of the impacted canine, as recorded from the beginning of the interdisciplinary therapy until completion (bracket-debonding) of the orthodontic treatment. Secondary outcome variables were the durations of the following stages of therapy:

- Stage 1: Start of treatment until first clinically visible movement of the impacted canine.
- Stage 2: First visible movement until full eruption of the canine crown into the oral cavity, enabling bonding of an orthodontic attachment or bracket.
- Stage 3: Eruption until alignment of the canine into the dental arch, enabling the insertion of a rigid rectangular archwire (stainless steel or titanium molybdenum archwire).
- Stage 4: Insertion of a rigid rectangular archwire until completion of the orthodontic treatment (bracket-debonding).

The incidence of repeat surgery was analysed with regard to the following potential confounders: gender and age of the patient, number of impacted canines (unilateral or bilateral impaction), location of the impacted canine, as well as the original surgical approach (open vs. closed exposure). These data were obtained by reviewing the three-dimensional CT scan and clinical records from the time of surgery as well as from monthly follow-ups during the ensuing orthodontic treatment. Impacted canines were classified as buccally, centrally, or palatally displaced by examining the "low-dose" CT images (Tomoscan SR-6000, Philips Medical Systems, Eindhoven, Netherlands; 1.5-mm slice thickness, 1-mm table feed, 120 kV, ≤25–50 mA/s, 2-second scan time/slice, 512 matrix, bone window) (Gahleitner et al., 2003). For treated canines, either open or closed surgical exposure technique was recorded. Canines subjected to gingivectomy, apically positioned flap surgery, or pre-orthodontic uncovering technique were included in the open exposure group (Kokich and Mathews, 1993). The closed exposure group included all canines, surgically uncovered with the flap/closed eruption technique (Kokich and Mathews, 1993).

A potential source of bias in the evaluation of treatment of impacted maxillary canines is the canine's position within the maxilla. To address this, the inclusion of patients was based on the availability of a CT scan, which allowed a better classification in this regard.

All data were described with frequencies and percentages for categorical data, and with median, minimum, and maximum for continuous data. Associations between two categorical covariates were tested using the chi-square test. If data were sparse, Fisher's exact test was used for 2×2 tables and an exact chi-square test for 2×3 tables. Group differences of a continuous variable were tested using the Wilcoxon rank-sum test for the comparison of two groups, and using the Kruskal–Wallis test for the comparison of three groups. An exact version of these tests was used for group sizes of less than 10 patients. Associations between two continuous variables were assessed using Spearman's correlation coefficient. All tests performed were two-sided, and a p-value of <0.05 was considered statistically significant. All statistical analyses were performed using SAS statistical software (version 9.2, SAS Institute Inc., Cary, NC, USA).

3. Results

Of 440 patients referred for CT examination, 55 patients with 79 impacted maxillary canines were included in this analysis. Recruitment details are presented in Fig. 1. Age ranged from 11 to 52 years, with a median age of 16 years (mean 19.1 ± 7.8 years).

Of 55 patients, 46 (83.6%) did not present with complications that would have prompted repeat surgery during their treatment. In 77.8% (n = 7) of patients requiring repeat surgery, one additional exposure procedure sufficed, while 22.2% (n = 2) needed a third surgery. Table 1 shows that among the confounders analysed, the need for additional surgical procedures showed no significant relation to gender ($p = 0.71$), age ($p = 0.19$), number of impacted canines ($p = 0.72$), or their location within the alveolar bone ($p = 0.51$). However, additional surgery was required significantly more often following a closed exposure technique, as compared to an open exposure technique ($p = 0.03$).

Overall treatment time for complete alignment of impacted canines ranged from 19 to 52 months (median 31 months). Treatment time of patients who required repeat surgery did not

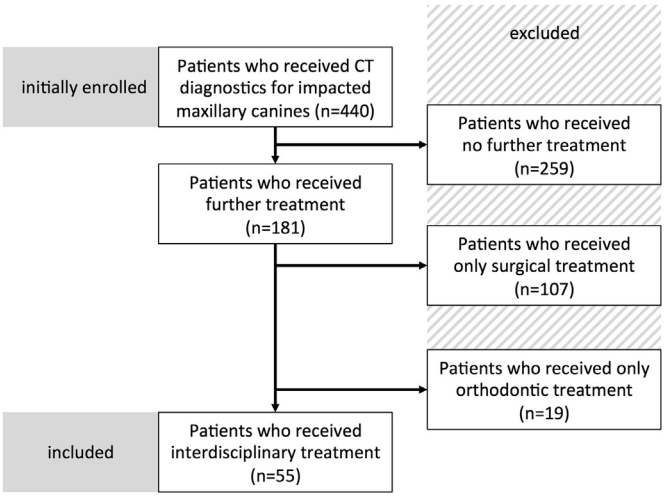

Fig. 1. Flowchart of patient recruitment during the 5-year observation period.