Survival of palatal miniscrews used for orthodontic appliance anchorage: A retrospective cohort study

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Introduction: The purpose of this study was to examine the overall success of miniscrews inserted in the paramedian palatal region for support of various appliances during orthodontic treatment. Methods: The patients received 1 or 2 miniscrews in the paramedian anterior palate of 8.0-mm length and 1.6-mm diameter placed during orthodontic treatment by the same experienced orthodontist. Results: In total, 196 patients (121 girls, 75 boys; median age, 11.7; interquartile range, 3.7) who received 384 miniscrews were evaluated. Two hundred four miniscrews were used with rapid palatal expansion appliances, 136 with appliances for distalization of posterior teeth, and 44 with other appliances, such as transpalatal arches for tooth stabilization. The overall survival of the miniscrews was excellent (97.9%) in the cases examined. Cox regression analysis showed no difference in the overall survival rates of miniscrews loaded with different appliances for sex (hazard ratio, 0.95; 95% confidence interval, 0.71-1.27; P = 0.73) after adjusting for appliance and age. Conclusions: This study shows that miniscrews placed in the paramedian anterior palate for supporting various orthodontic appliances have excellent survival. (Am J Orthod Dentofacial Orthop 2013;143:767-72)
Until now, several studies have assessed the success of palatal implants for anchorage in orthodontic treatment. However, implants have 2 important disadvantages compared with miniscrews: they require, for osseointegration purposes, approximately a 3-month latency period before loading and consequently surgical intervention to remove them. Miniscrews have been placed in the midpalatal area with encouraging results, and recent studies have reported high success rates (90.8%-95.6%). Another option, especially for young patients whose palatal suture is not mature, is the placement of miniscrews in the paramedian palatal area, where the host hard-tissue parameters favor miniscrew placement.

To our knowledge, the survival of miniscrews placed in the paramedian palatal area has not been adequately investigated until now. Thus, the aim of this retrospective cohort study was to evaluate the survival of palatal miniscrews placed in paramedian regions and used for supporting various appliances during orthodontic treatment.

**MATERIAL AND METHODS**

The sample was selected from a private orthodontic practice in Traben-Trarbach, Germany, and included all orthodontic patients treated with skeletal anchorage supported appliances placed in the palate. Patients received 1 or 2 miniscrews (Ortho Easy; Pforzheim, Forestadent, Germany) of 8.0-mm length and 1.6-mm diameter placed during orthodontic treatment by the same experienced orthodontist (B.L.). The miniscrews were inserted under superficial and subsequent local anesthesia in the anterior region of the palate, 3 to 6 mm paramedian to the suture and 6 to 9 mm distal to the incisive foramen. The insertion was performed with a surgical treatment unit with a maximum rotation rate of 60 rpm. In the same appointment, an impression was taken, and within 1 week an appliance was placed. The peri-implant soft tissues and the hygiene status were controlled in every appointment by visual inspection as a standard protocol. After insertion, all patients were told to minimize any possible contact of the miniscrews with their fingers or tongue. Furthermore, the patients were instructed to brush the miniscrews and abutments routinely once a day to prevent soft-tissue inflammation or overgrowth.

The orthodontic appliances supported by the miniscrews were of 3 main categories: rapid palatal expansion appliances, appliances for distalization of posterior teeth, and other appliances such as transpalatal arches for posterior tooth stabilization or segmented palatal arches for incisor stabilization (Fig 1).

For each patient, the following data were collected: medical and dental histories, sex, age, date of miniscrew insertion, type of appliance, date of appliance insertion,
Time to miniscrew success was explored with statistical methods for survival analysis, and miniscrew survival hazard ratios for sex adjusted for age and appliance were calculated with Cox proportional hazards regression modeling, accounting for clustering effects. For the calculation of the miniscrew and appliance survival period, the time from implant placement until appliance removal was used. In all cases, appliances were placed within 1 week after implant insertion, and no miniscrew failed before appliance placement.

The proportional hazard assumptions were assessed using log-log plots, comparing fitted and predicted Kaplan-Meier plots, and on the basis of Schoenfeld residuals. All analyses were conducted with the STATA statistical package (version 12.1; StataCorp, College Station, Tex).

**RESULTS**

In total, 384 miniscrews that supported 196 appliances were inserted for orthodontic anchorage purposes in the paramedian anterior palate of 196 patients in a 5-year period (June 2006-May 2011). Patient flow is shown in Figure 2, and their demographic and clinical characteristics are summarized in Table I.
Of the entire sample, only 8 patients received 1 miniscrew on the right side of the palate, and all were in the “other appliances” group. Single miniscrews were used only for indirect anchorage. The remaining 188 patients received 2 miniscrews each, one at the right and the other at the left side of the palate, for appliance support. At the end of the observation period, 13 patients (25 miniscrews: 12 with 2 miniscrews, and 1 with 1 miniscrew) were still in treatment.

The survival of the miniscrews was excellent in all cases examined, as shown in Table II. Of 384 miniscrews, only 8 failed; 2 were in the same patient. Of the failed miniscrews, one that supported a rapid palatal expansion appliance broke after 2.3 months of use, and the remaining 7 were removed because of extensive mobility.

Failures were evenly distributed in the 5-year interval when the appliances were used; thus, the potential influence of experience with appliances on miniscrew survival was not evident. Table III shows the number of successful miniscrews, medians, and range of months of follow-up overall and by sex and type of appliance.

Cox regression modeling showed that sex was not a significant outcome predictor after adjusting for age and appliance type (hazard ratio, 0.95; 95% confidence interval, 0.71–1.27; P = 0.73) (Table IV, Fig 3). Significant differences in the hazard ratio between appliance type and age groups indicate only that the various appliances were worn for different time periods and by different age groups, and do not necessarily indicate the instant probability of miniscrew success. Of the 8 miniscrew failures, 7 were inserted in the left and 1 in the right paramedian region.

**DISCUSSION**

The purpose of this study was to assess the survival of miniscrews placed in the paramedian area of the anterior
palate that were used for supporting various orthodontic appliances. The overall survival of the paramedian miniscrews in our study was very high, reaching 97.9%, and was similar to that of paramedian palatal implants.9 Previous studies also reported high success rates for midpalatal orthodontic miniscrews ranging from 90.8% to 95.6%.12,13

To our knowledge, this study is the first to analyze such a large number of paramedian orthodontic miniscrews (n = 384). The finding of successful miniscrew placement in the paramedian region of the anterior palate is considered important, especially for young patients with an immature midpalatal suture. An animal study raised the issue of growth interference when palatal implants are placed in the midline.14 Apart from growth interference, midpalatal miniscrew insertion in young patients might be associated with reduced primary stability and disturbances with the early healing process.

The excellent survival rate in our study can be attributed to several factors. One experienced practitioner (B.L.) inserted all miniscrews in the same region of the palate following the same protocol.20 All miniscrews were identical, had adequate size and length (diameter, 1.6 mm at the tip and 1.8 mm at the end of the thread; length, 8.0 mm),21 were loaded within 1 week, allowing for an undisturbed early healing period, and were placed in a region with favorable anatomic hard-tissue parameters that are considered important for successful miniscrew insertion and retention.7

According to our results, fixed orthodontic appliances can be combined with skeletal anchorage in the palate with high survival rates, thus reducing the risk of unsuccessful treatment outcome because of lack of patient cooperation or treatment-related complications. In particular, distalization of the maxillary molars, expansion of the maxilla, and enhancement of anchorage can be predictably accomplished with the described protocol, reducing the required patients’ compliance level. However, good oral hygiene, absence of inflammation, and tooth and periodontal tissue integrity remain crucial for miniscrew survival.17

In our study, miniscrews placed on the left side (7 of 8) were more likely to fail compared with the right side. The only failure at the right side was when both of the patient’s miniscrews failed almost simultaneously. When only 1 miniscrew was placed (n = 8), the clinician preferred consistently to place the miniscrew on the right side. This might imply that the clinician considered this position more comfortable, and thus the difference between the left and right sides could be influenced by parameters related to the doctor (ie, insertion procedure) and not by the anatomic characteristics of the region. However, this finding should be interpreted with caution, since data on failures were thin.

Fig 3. Kaplan-Meier survival estimates by sex. The y-axis shows the proportion of patients with stable implants at different time points (months on the x-axis). By drawing a line perpendicular to the x-axis at a given time, the proportions of patients not completing the miniscrew supported part of treatment for each sex group are extrapolated from the corresponding value of the y-axis.
Sex was not found to exert a significant influence on miniscrew success rates, and age and appliance type indicate only the different time periods that the various appliances were worn.

The limitations of this study can be attributed mainly to its retrospective nature. Retrospective data collection might introduce selection and detection bias. To reduce selection bias, all patients who fulfilled the inclusion criteria were included in the study. Detection bias is unlikely to be an issue because miniscrew loss is a hard outcome.

These results are expected to apply in a wide age range and settings where equipment availability and similar levels of experience in implant insertion are available.

CONCLUSIONS

This study showed excellent performance of miniscrews placed in the paramedian area of the anterior palate in conjunction with various orthodontic appliances and for distinct orthodontic treatment needs.

REFERENCES