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Periodontal status of palatally displaced canines - The impact of surgical technique

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ABSTRACT

This article examines the available published evidence that addresses the research question 'is a closed or an open surgical exposure for an unerupted palatally-positioned/displaced canine (PDC) better for the long-term periodontal health of the canine and surrounding teeth?' Flaws in the current evidence are discussed and a way forward is suggested.

Introduction

Patients with an unerupted palatally-positioned/displaced maxillary permanent canine (PDC) are a common clinical presentation in orthodontic practice. Management frequently involves surgical exposure and orthodontic alignment. The ideal clinical outcome is an aesthetically pleasing alignment of the canine within the dental arch and minimum disruption to the supporting structure of the tooth. This is best done in a reasonable time frame of two to three years to avoid burden to the patient and high cost.

The two main surgical techniques involve either uncovering the unerupted tooth through removal of palatal tissue (with or without a temporary covering to prevent tissue regrowth) and placement of an orthodontic attachment later, after further eruption of the tooth (open technique – Fig. 1) or placement of an orthodontic attachment during surgery and replacement of the surgical flap, allowing orthodontic alignment to start under the palatal tissues sooner (closed technique - Fig. 2).

Several advantages and disadvantages of each surgical technique have been suggested.[1,2] One proposed advantage of the open technique is that the crown of the exposed canine can be clearly seen, and an attachment placed after surgery, when the mucosa is healed. Potentially there is a risk that an attachment placed during closed surgery will debond or that the palatal gingiva re-covers the canine following open surgery. These post-operative complications might require the patient to undergo a second surgical procedure; however, the reported incidence of post-operative complications has been low in two randomised controlled trials to-date.[3,4] Another potential advantage of being able to see the crown of the canine following open surgery is that force can be applied in an appropriate direction, away from surrounding teeth (Fig. 3). Following a closed exposure it is more difficult to direct the force appropriately and may lead to the unerupted tooth impacting against adjacent teeth. It has been suggested that this could lead to longer treatment times for some patients who have had a closed exposure. Parkin and colleagues report that all seven participants in their RCT who were in active traction for more than 18 months had a closed exposure, suggesting that alignment time was more unpredictable following this procedure.[5] Another potential problem with the closed technique is that the palatal surface of the unerupted canine is often the most accessible for the surgeon to place the orthodontic attachment. Application of force to an attachment on the palatal surface leads to undesirable rotation of the teeth, which must be corrected later, prolonging the alignment phase (Fig. 4). Conversely advocates for the closed technique propose that the periodontal health of the canine is better if it is allowed to erupt 'naturally' through the gingiva, compared with an open surgical exposure.

In this article we will not attempt to address all the potential advantages and disadvantages of the two techniques, but examine the evidence to answer the research question 'is a closed or an open surgical exposure for an unerupted palatally-positioned/displaced canine better for the long-term periodontal health of the canine and surrounding teeth?'

Reviews

Numerous reviews have been undertaken to try to answer this question. One of the first was by Burden and colleagues.[6]. This narrative

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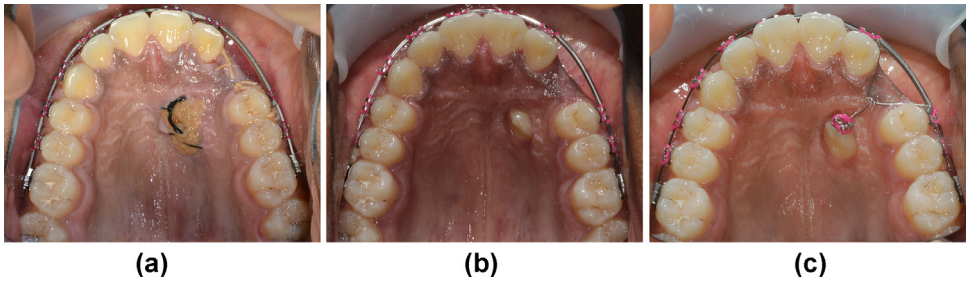

Fig. 1. An open surgical exposure with a) a gauze pack in place to prevent palatal tissue overgrowth b) the pack removed and c) starting alignment.

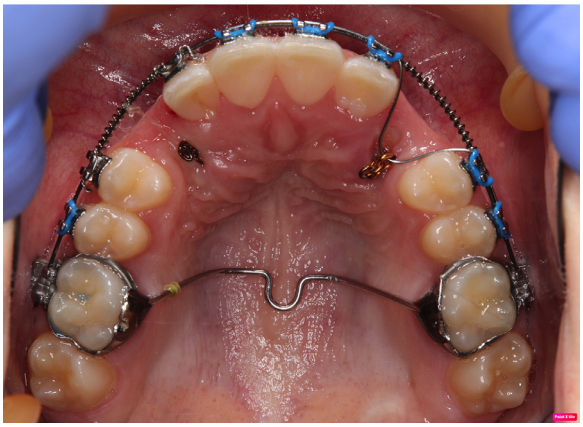

Fig. 2. A closed surgical exposure with bonding of gold chain.

Fig. 3. Force being applied in an appropriate direction following an open exposure to move the canines distally away from the lateral incisors.

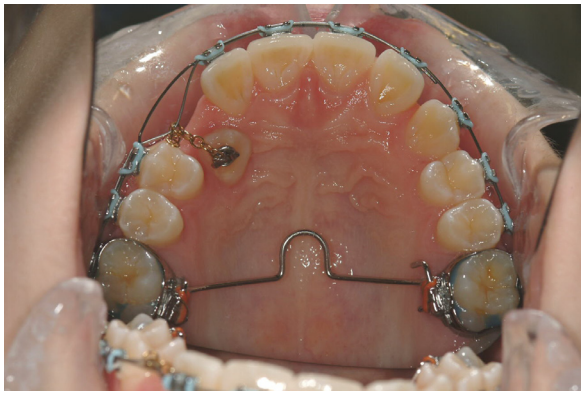

Fig. 4. Attachment placed on the palatal surface of the canine leading to undesirable rotation.

review examined several outcomes, but in terms of long-term periodontal health concluded that there was no clear answer.

One of the first systematic reviews in this area was undertaken by Parkin and colleagues in 2008 and updated in 2017.[7] The updated review included only three studies; one randomised[8] and two quasi-experimental studies (with alternate allocation to either an open or a closed surgical exposure).[9,10] Gharaibeh and colleagues did not include periodontal outcomes in their report. Parkin and colleagues reported clinical periodontal attachment levels, palatal gingival recession, crown height, and radiographic alveolar bone levels 3 months after orthodontic alignment of the PDC and removal of the fixed orthodontic appliance. Smailiene and colleagues reported periodontal pocket depth, gingival recession, and width of keratinized tissue between 3 and 6 months after alignment of the PDC and removal of the fixed appliance (mean 4mths). Both studies only recruited participants with a unilateral PDC, therefore were able to compare the periodontal health of the treated canine with that of the contralateral, untreated canine. Although data from the two studies was not combined into a meta-analysis, the findings were similar, both concluding that there was a small, clinically insignificant impact on the periodontal health of a PDC following treatment, with approximately 0.5mm lower clinical periodontal attachment level compared with the contralateral untreated canine. There were no differences in the periodontal outcomes of PDCs treated with either an open or a closed surgical technique.

Several further systematic reviews in this area have been published since. Sampaziotis and colleagues[11] included one randomised controlled trial (RCT),[8] two quasi-experimental,[9,10] and three observational studies (with retrospective participant identification) in their review.[12-14] The quasi-experimental and observational studies were judged to be at a high risk of bias. Periodontal outcomes were reported by the RCT, one quasi-experimental,[10] and one observational study.[12] and only the RCT was judged to be at a low risk of bias. The authors of this review indicate that periodontal outcomes were similar between those treated with an open exposure compared with those treated with a closed exposure, but they were unable to undertake a meta-analysis by combining the results of two or more studies, so the certainty of any conclusions is low. De Araujo and colleagues reached the same conclusion.[15]

In another systematic review Cassina and colleagues[16] included two RCTs (one in which participants with unilateral PDCs were recruited[8] and one in which participants with unilateral and bilaterally unerupted buccally displaced, maxillary canines were recruited,[17]), two studies with quasi-experimental designs,[9,10] and four observational studies.[18-21] One observational study, involving 60 patients scheduled for surgical exposure of either impacted maxillary incisors or canines clearly identified participants over a 12-month period prior to treatment, as post-surgical questionnaires were administered. The reports of the other three prospective studies did not clearly explain whether participants were prospectively identified before treatment commenced. One study, describing itself as a 'prospective clinical study', reported outcomes from 118 patients with unerupted canines treated over an 18-year period and no withdrawals and drop-outs.[21]

No periodontal outcomes were reported in this review despite the authors stating that they were attempting to evaluate any 'harms of the open exposure' compared with a closed exposure in the management of impacted canines. The combining of treatment data from participants with buccally displaced unerupted canines and participants treated for a PDC, as well as those treated for unerupted incisors further complicates the interpretation of any findings.

Grisar and colleagues published a review, which included studies involving participants who received interceptive treatment to encourage the eruption of the unerupted tooth, as well as those receiving surgical treatment.[22] The report also included studies containing participants who had buccally displaced canines, as well as PDCs. They noted that four of their included articles reported a periodontal outcome;[23-26] however, the relationship between initial canine position and periodontal outcomes was contradictory and unclear. As a result of the heterogeneity of the included studies no meta-analysis was performed.

Two recent reviews attempt to provide an estimate of the periodontal impact following surgical exposure and orthodontic alignment of unerupted maxillary anterior teeth. These reviews combined data from both unilateral unerupted incisors and canines (palatally and buccally-positioned), using any type of surgical exposure, with and without a comparison group.[27,28] Both these reviews undertook a meta-analysis by combining data from studies regardless of their methodological quality. They conclude that surgical exposure and orthodontic alignment had a modest adverse effect on the periodontal outcomes compared to the contralateral normally erupted tooth, although the authors recognise that the majority of studies were of low methodological quality.

Reports of another RCT comparing outcomes in participants with a PDC treated by open surgical exposure with those by closed surgical exposure have recently been published.[4,29] This study included participants with both unilateral (n = 87 followed-up) and bilateral (n = 30 followed-up) PDCs. Periodontal measurements, including pocket depth, gingival retraction and alveolar bone height (measured from CBCT radiographs) were collected as secondary outcomes. Final clinical measurements were undertaken when 'the PDC was in its correct position with sufficient root torque in the dental arch, passively ligated to a square stainless steel archwire'; therefore, before the fixed appliances had been removed. Small, clinically insignificant differences (<0.5mm) were found in some of the measurements on the treated canines and adjacent lateral incisors between participants in the closed and open groups; however, as the fixed appliances were still in place, when the measurements were undertaken, the final periodontal health after orthodontic treatment is unclear. In addition, due to the inclusion of participants with bilaterally displaced and treated canines, comparison of periodontal outcomes with the contralateral untreated canine was not reported.

Ankylosis, with partial loss of the periodontal ligament of the surgically exposed tooth and replacement with bone, has been suggested as a potential complication following surgical exposure of an unerupted canine[7], yet neither RCT report patients identified with this condition.[8,29] In their review Cassina and colleagues state that patients undergoing an open exposure are at a lower risk of ankylosis.[16] This appears to be based on data from eleven teeth with ankylosis (out of 119 undergoing surgery) in one report, derived from a sample of retrospectively identified patients, treated with surgery, for 'impacted' canines, in one practice.[21] There are other isolated reports of ankylosis following surgical exposure;[13,22] however, the numbers are much too small, and the studies are of such low quality, to provide any certainty concerning a difference in the incidence of ankylosis between the two surgical techniques. The authors of this article have a special interest in managing patients with unerupted canines and receive referrals from other orthodontic practitioners having difficulties aligning an unerupted canine. Our clinical impression is that all patients diagnosed with either an ankylosed or pseudo-ankylosed canine have been previously exposed using a closed procedure, but this requires further investigation.

Non-experimental study designs limit the certainty of the evidence

These reviews highlight the uncertainty in our knowledge and understanding about the effects of surgical exposure on the short and long-term periodontal health of the unerupted canine and the surrounding teeth. This is mainly due to a paucity of good quality research and deficiencies in much of the published literature, which need to be addressed in future research. For a full list of the articles examined and the judgments made please see the supplementary materials.

The largest proportion of articles in the current literature reporting the effect of surgery to uncover an unerupted canine on periodontal health are non-experimental or observational (sometimes known as 'real-world') studies. In non-experimental research patients who are having or who have had surgery to uncover an unerupted PDC are simply observed, and the investigator has no control over which treatment is provided. Most of the reports either directly or indirectly imply that patients in their samples were identified after treatment had been provided (see supplementary materials} We found three reports of the same sample of patients who were 'consecutively treated…over a period of 17 years' by a single private practitioner in Italy; however, from the description in the report the patients in the sample were almost certainly identified after treatment was complete. These studies are at an increased risk of selection and allocation bias, whereby the clinician decides which surgery might be appropriate for each individual patient, as well as attrition bias, whereby participants are lost to follow-up, with potential problems not recorded. Many reports provide no information about when the patients in their samples were identified, making their risk of bias less clear.

The reporting of sampling methods was poor or non-existent. Most reports were judged to have used convenience sampling to identify the patients to include in the study. A frequent approach in convenience sampling is to use patients with a complete set of measurable records. This is straightforward and inexpensive; but the sample will be at a high risk of selection bias. Clinicians frequently collect records of successfully treated patients and not so frequently of unsuccessfully treated patients. The proportion of unsuccessfully treated patients will be lower in the sample; therefore, the sample will not be representative of the overall population of patients treated for the condition. This reduces the generalisability of the findings.

Smailiene and colleagues report that they identified patient participants before the start of the treatment and followed-up them throughout the course of their treatment.[10] This study is a quasi-experimental design, as patient participants were assigned alternatively to receive either a closed surgical exposure or an open surgical exposure. This prospective design has the advantage that patients lost-to-follow-up, with potentially worse outcomes, can be accounted for, but, rather unusually for a prospective clinical study, the authors do not report any withdrawals or dropouts in the 43 participants over the five years the study was conducted.

The majority of studies included patients with only a unilateral unerupted upper canine, enabling a comparison between the treated and untreated contralateral teeth. Some studies include patients with bilateral unerupted canines and, therefore were unable to compare the periodontal outcomes with the contra-lateral untreated canine. Some studies included data from the treatment of both buccally displaced unerupted canines, as well as palatally displaced unerupted canines. Aligning buccally displaced unerupted canines, usually through non-keratinized gingiva, represents different mechanical and periodontal challenges than palatally displaced unerupted canines through keratinized palatal tissue; (Fig. 5) therefore, we do not believe that it is valid to combine data from the treatment of these two types of displaced teeth. Some studies simply described the patients as having 'impacted canines' without any indication about whether the unerupted tooth was displaced or not. The word 'impaction' implies that the unerupted tooth is prevented from eruption due to lack of space between adjacent teeth, whereas many patients with palatally displaced canines have adequate space for the unerupted tooth within the dental arch (Fig. 6). One study included data from treated and untreated patients, some treated with fixed appliances,

Fig. 5. There are often different mechanical and periodontal challenges to aligning a buccally-placed canine compared with a PDC and combining data from the two might not be valid.

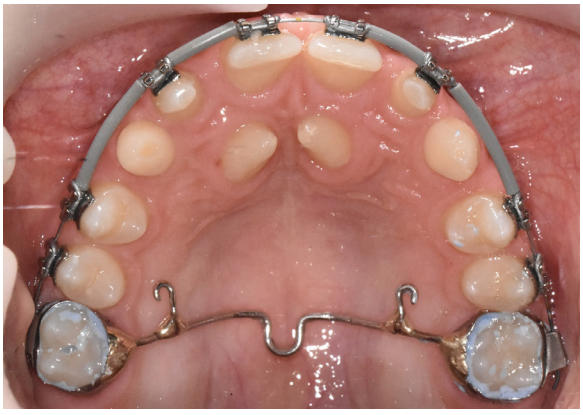

Fig. 6. The maxillary canines are significantly displaced towards the midline, but with more than enough space within the dental arch they cannot be described as 'impacted' (nor is it likely that the retained primary canines are responsible for the displacement). Note the diminutive lateral incisors which some evidence suggests are associated with a PDC.

some with removable appliances and some having the canine transplanted or even extracted. One study included data from patients with unerupted incisors and premolars. The interpretation of these data is very uncertain and future studies should avoid combining too many heterogeneously managed groups of patients.

Some articles report the outcomes from groups of patients, treated using different surgical techniques, whereas most reports of non-experimental studies supply data on only a single group of patients treated using the same surgical technique, most frequently a closed surgical procedure. This makes comparisons between surgical techniques very uncertain.

The reported number of patients identified from which the sample was obtained varies from 15 to 406 with a median number of 48. The number of patients in which data are analysed and reported varies from 15 to 271, with a median number of 31. A sample size of 15 is little more than a case series and unlikely to produce meaningful data with any degree of certainty. One issue with the sample sizes in these studies is that periodontal outcomes are very often secondary to other outcomes that are considered by clinicians (and occasionally by patients) to be more important. This might include the length of a specific part of treatment, such as eruption or alignment of the unerupted tooth or occasionally the complete length of active orthodontic treatment. The size of a study sample should be justified on the basis of finding a clinically significant difference in what is considered to be the most important outcome. Therefore, if periodontal outcomes are considered secondary, then the number of patient participants might not be sufficient to find a clinically significant difference in any periodontal outcomes. As most studies did not report a sample size calculation then we do not know whether the sample was sufficient to detect a clinically significant difference (if one actually exists) or even what the investigators considered to be the most important outcome.

Some reports either explicitly state or implicitly describe that the data collected and analysed were from patients treated in single centre. Just four reports explicitly state that the patient participants were treated in more than one centre. In some reports the treatment setting is unclear. It is essential to report the setting of the study to allow the reader to understand and interpret the generalisability of the findings.

The reported mean length of follow-up varied from 4 months (range 3 to 6 months) to 12.3 years (range 1 to 18 years) after fixed appliances removal. One study described the follow-up as a mean of 2yrs 7mths after 'completion of retention', which most clinicians nowadays, probably would not recognise as a valid starting end point. Two reports state that patient participants underwent two periodontal evaluations 'at the end of active treatment' and another after an average period of 39 months and after 2.4 to 4.5 years. Neither report explains exactly when the initial periodontal examination was undertaken, but if on the day of debond, then outcomes such as plaque, gingival and bleeding indices, as well as pocket depths are likely to be poor.

Other issues with interpreting the research in this area, include combining data from adults and young people treated for the condition, as well as multiple reports of similar outcomes from the same group of patients. However, a major obstacle in determining the certainty of the findings is the lack of agreement about which outcomes to assess and report, and at which timepoints. All reports included data on periodontal pocket depths, but only a minority reported clinical attachment loss, gingival recession, gingival aesthetics and alveolar bone height from radiographs. There was also great variation in the reported follow-up times. To increase the certainty and generalisability of the findings it is necessary for future researchers to combine data from different studies, carried out by different clinicians, in different centres into a meta-analysis. This can only be carried out if we can agree on the important outcomes to measure, in which sample of patients and at which timepoints. Some initial work has been carried out to develop a core outcome set for clinical trials in periodontology.[30] The authors concluded that probing depth is a core outcome, but when and how to measure this has yet to be determined. Adequate training and calibration of examiners to collect periodontal measurements is essential to ensure adequate accuracy.[31] 'Periodontal effects' were identified as a core outcome in the 'Adverse effects and/or events' of a core outcome set in orthodontic research,[32] but the 'what, how and when' are yet to be decided.

Experimental studies

As previously highlighted, there are just two reports in the orthodontic literature of experimental/interventional appropriately randomised studies to investigate the effects of surgery to expose an unerupted PDC on periodontal health.[8,29] In experimental/interventional studies the investigator has control over the patient participants included in the study and what treatment (in particular, which intervention of interest) they receive through random allocation. This reduces the potential for selection and allocation bias, whereby the clinician decides which surgery might be appropriate for each individual patient. This also helps to account for potential confounders, such as the age of the patient, the severity of the displaced canine and the susceptibility to periodontal disease of each individual patient. If the random allocation is undertaken appropriately and the sample size is large enough (see comments about primary and secondary outcomes), then confounders that could influence the outcome will be equally distributed between the comparison groups reducing the risk of a spurious association between the intervention of interest and the outcome. In addition, as experimental studies, by necessity, are undertaken prospectively, with participants identified before the start of any treatments and follow-up throughout (hopefully to the end of treatment and beyond) this reduces the risk of attrition bias, whereby participants are lost to follow-up and potential problems are not recorded.

Objections to experimental, randomised controlled trials include for reasons of ethics or practicality. An intervention or an outcome might be so extreme that it is not ethical to expect patients to accept that a

computer will decide which treatment they will receive, or the study might be so costly and/or lengthy to undertake that it might not be practical. It has also been argued that outcomes from a highly selective sample of participants in a randomised controlled trial make the results less generalisable to a 'normal' population of patients. We believe that these objections are not relevant to the question about whether a closed or an open surgical exposure for an unerupted PDC is better for the long-term periodontal health of the canine and surrounding teeth. The interventions are similar, the outcomes measurable and most centres should be able to recruit a suitable number of representative patients. We genuinely do not know for sure (rather than think) whether one surgical technique is superior to the other, in any of the relevant outcomes, so clinicians should have equipoise and be prepared to randomise patients to either technique.

Summary

Data from clinical studies to-date suggest that, although there might be a small and probably clinical insignificant difference in short-term periodontal outcomes between unerupted PDCs that have been surgical exposed compared with canines that erupt naturally, there are no differences between those surgically exposed using a closed compared with an open technique. However, flaws in the non-experimental study designs limit the certainty of these findings. In addition, long term data (greater than 5 years post-treatment) are very limited. Further systematic reviews in this area are unlikely to change our knowledge and understanding for the foreseeable future. If we are to increase the certainty in our knowledge and understanding of the effects of surgical treatment on an unerupted maxillary canine, then more data from well-designed, experimental, randomised clinical studies are required. Agreement on a core set of outcomes (what to measure, how and when) is also required.

Patient consent

Patient consent was obtained.

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Author contributions

All authors attest that they meet the current ICMJE criteria for authorship.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1053/j.sodo.2023.11.008.

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