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Scientific Section

Eruption of Palatal Canines Following Surgical Exposure: a Review of Outcomes in a Series of Consecutively Treated Cases

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Abstract: *The records of a consecutive series of 72 patients who had undergone excisional exposure of one or both palatally displaced canines were reviewed. The purpose was to ascertain whether the canine(s) erupted spontaneously following surgery, whether orthodontically-assisted eruption was required or whether the procedure failed completely indicating the need for re-exposure. The results of the study suggest that the majority of canines will erupt once exposed and of those that fail to erupt completely most will still remain exposed to a sufficient extent to allow attachments to be bonded to the palatal surface.*

Index words: Unerupted Canine, Surgical Exposure

Introduction

Palatal impaction of the maxillary canine is a problem which is frequently encountered in orthodontic clinical practice, although the overall population prevalence is fairly low. Ericson and Kurol (1986) found evidence of abnormal canine eruption patterns in 1·7 per cent of children aged 11 years and over. They quoted several earlier studies which were in broad agreement with this estimated frequency. Once it is established that the canine is displaced from its normal position, management options can be categorized as:

1. No immediate treatment except monitoring
2. Surgical removal of the unerupted canine
3. Accomodating the canine within the arch

The indications for and against these various treatment options have been covered elsewhere (Moss, 1972; Bishara, 1992; Ferguson, 1990).

Accommodation of the canine within the arch can involve procedures of varying complexity, ranging from the simple removal of any impediments to eruption (including retained deciduous canines) up to surgical reimplantation. A strategy which is commonly adopted is surgical exposure followed by orthodontic alignment. The two main surgical approaches are:

1. Replaced flap techniques, whereby the soft tissues are replaced over the exposed tooth after attaching a chain or other device with which to apply traction.
2. Excisional exposure in which mucosa overlying the crown is sacrificed and the wound packed open.

Heaney and Atherton (1976) stated that the latter technique is acceptable provided that the tooth can be exposed within a zone of keratinised mucosa. Kohavi *et al.* (1984) stressed that such exposure must be conservative and should not involve the cemento-enamel junction in order to minimize potential periodontal complications following tooth alignment.

Even when a decision has been made to undertake excisional exposure, there are two further options to be considered. The first of these is to permit natural eruption of the canine and the second is to place an attachment on the tooth at or very soon after surgery to facilitate orthodontically-induced eruption. Advantages and disadvantages have been cited for each method (Bishara, 1992; McSherry, 1996). One of the perceived problems of leaving the tooth to erupt naturally is that gingival regrowth may occur, necessitating a further surgical procedure. However, there is little objective evidence regarding the success or otherwise of leaving palatal canines to erupt, as opposed to applying traction immediately after surgery. Therefore, a retrospective study was undertaken of a series of consecutive procedures carried out by one of the authors (JWF). All of the patients involved had undergone exposure of a palatal canine or canines with the intention that the teeth should be allowed to erupt naturally prior to orthodontic alignment.

Materials and Methods

The clinical records of 72 consecutive patients who had undergone excisional exposure of one of more palatal canines were reviewed. The method of surgical exposure and packing employed was that previously described by Ferguson (1992). An approximately circular full-thickness incision was made through the palatal mucoperiosteum overlying the canine crown, the position of which had been assessed from the radiographs and/or by palpation. The segment of mucosa enclosed by the incision line was then

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dissected off the bone, the bony covering itself being removed either with a Mitchell trimmer (if very thin) or a bur under saline irrigation. Where the canine was covered by soft tissue alone, the Mitchell trimmer was used to scrape the follicular tissue from the palatal surface of the enamel. The cavity was enlarged if necessary, by further soft tissue and/or bone removal as required, in order to expose the entire palatal surface from cusp tip to cingulum, but leaving the cementoenamel junction undisturbed. The wound was packed using a light-cured periodontal dressing (*Barricaid: L.D. Caulk Dental Division, Dentsply International Inc., Milford, Delaware, U.S.A.*) retained by sutures. Standard post-operative instructions included the use of hot saline mouthwashes starting on the day after surgery; neither antibiotics nor antiseptic mouthwashes were prescribed routinely. Following removal of the surgical pack, the patients were asked to re-attend for a further review after 2–3 weeks. Figure 1 illustrates a typical exposure and the subsequent eruption of the canine.

The following criteria were noted for each patient:

1. Tooth/teeth exposed.
2. Date of exposure.
3. Age of the patient at the time of exposure.
4. Date of pack removal.
5. Date of first review following pack removal.
6. Date of bonding an attachment to the buccal aspect of the canine(s), assuming a successful outcome had been achieved.
7. Recorded complications or departures from the standard procedure.
8. The position of the canine(s) on the dental pantomogram, using the method described by McSherry (1996). This estimates the prognosis for alignment of the canine by reference to the amount by which the crown overlaps the incisor roots in both the horizontal and vertical planes. The closer the canine lies to the midline in the horizontal plane and to the apical third of the incisor roots in the vertical plane, the poorer the prognosis.

The outcome was assessed against a predetermined standard, namely that the tooth should have erupted to the extent that bonding of an attachment to the buccal surface was possible, without the need for any further orthodontically assisted eruption (see Fig. 1d). The outcome was judged as successful (S) if it met the above criterion, partially successful (P) if sufficient tooth enamel still remained exposed to permit the bonding of an attachment on the palatal aspect which could be used to assist eruption, and as a failure (F) if a degree of gingival regrowth had taken place that would necessitate surgical exposure. This assessment was made according to the extent of canine eruption when the patient was sent for from the treatment waiting list (if applicable), although not all patients in which the exposure was successful actually proceeded to appliance therapy. If the surgical exposure had been undertaken during a course of treatment that was already in progress, the outcome was recorded at that stage in treatment where sufficient space had been created in the canine region for buccal movement of the tooth to be initiated. A further category (NK, not known) was

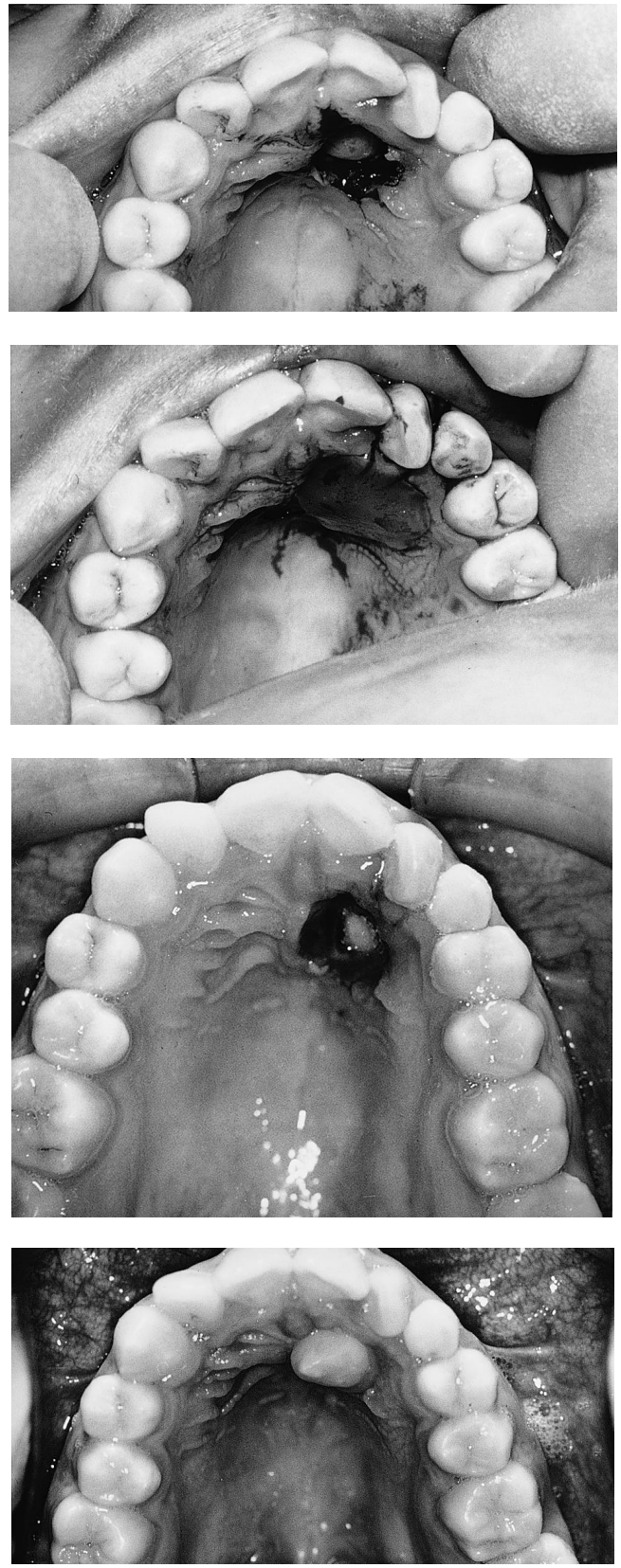

FIG. 1 A typical exposure of a palatal canine. (a) Directly after excision of overlying soft tissue and bone. (b) With pack sutured in place. (c) At pack removal (9 days after exposure). (d) Nine months following exposure, with canine fully erupted.

recorded for a few patients who discontinued treatment at an early stage.

Results

Outcomes

A definite outcome was recorded for 78 teeth, seven patients having failed to return for continuation of treatment when sent for from the waiting list. The outcome was successful (S) for 66 teeth (84·6 per cent of those with a known outcome), partially successful (P) in a further eight instances (10·2 per cent), signifying that the tooth remained exposed, but required some orthodontically assisted eruption from a palatal attachment before a bond could be placed on the buccal surface and recorded as a failure (F) necessitating re-exposure in four cases (5·1 per cent).

Details of patients in study

Of the 72 patients in the study, 18 were male and 54 female. Thirteen patients had bilateral procedures undertaken, thus making a total of 85 teeth exposed. The mean age of the whole sample was 15·9 years (range 11·2–37·7). For cases with a definite outcome, the mean age of the successful subgroup (S) was 15·1 years, compared to 17·1 years for the partially successful and failed groups combined (P + F). These groups were compared by means of a *t* test, but the difference was not statistically significant.

Post-operative management

The mean time that surgical packs were in place was 11·7 days, (range 4–20 days). Except for those patients who were already undergoing treatment at the time exposure was carried out, patients were seen for further review after a mean interval of 23·1 days (range 6–101 days). For those cases where eruption had been completely successful and who continued with appliance therapy, the mean interval between exposure and bonding an attachment to the buccal surface of the canine was 67·6 weeks (range 14·9–137·7 weeks).

Radiographic position

The positions of the canines on the dental pantograms (McSherry, 1996) were as follows:

Horizontal plane: poor, 38; fair, 33; good, 13.
Vertical plane: poor, 15; fair, 37; good, 32.

Radiographs were not available for one patient who had been transferred to another unit during treatment. The radiographic positions of the teeth in the successful group were compared to the remaining cases with known outcomes by means of χ^2 tests (with Yates correction factor applied because of small numbers in some cells). The results were statistically significant (horizontal position; $P<0.01$: vertical position $P<0.001$); nevertheless, the numbers of teeth in 'good' positions were still in a minority even for the successful cases.

Complications

Two patients experienced some post-operative bleeding, necessitating a further visit to arrest haemorrhage. One patient developed superficial post-operative infection necessitating early pack removal. In one case, there was some doubt about the eruption potential of the canine at the first review visit and light-cured composite (see discussion) was bonded to the exposed surface to guard against possible further encroachment of soft tissue. In all of the above cases, the eventual outcome was successful in that the canines subsequently erupted. A palatal bracket was also bonded to one canine where eruption was slow, but was subsequently removed (without actually being used to apply traction) as further spontaneous eruption occurred. Three patients (two of whom required bilateral exposures) had the procedure carried out under general rather than local anaesthetic; orthodontic extrusion was required in one of the bilateral cases, but the other teeth eruption without intervention.

Discussion

For those cases with a known outcome, the majority of teeth erupted successfully without further intervention, with most of the remainder still accessible for bracket bonding on the palatal surface at least. Only four teeth (5 per cent of the total) required re-exposure. With regards to the latter, there were problems of access in one instance due to inadequate co-operation at the time of surgery, and this patient required re-exposure of one canine even though the contralateral tooth had been exposed at the same time and erupted without problems. Another patient had been warned in advance that due to the deep position of the canine exposure might not be successful, and therefore decided to discontinue treatment at that stage. In the third case (another bilateral exposure) no specific reason could be identified for the rapid gingival regrowth, but both teeth were successfully re-exposed.

Even in the completely successful cases, the mean interval between exposure and bonding of an attachment to the buccal surface was fairly long. This was more indicative of the length of the waiting list rather than being a true representation of the time required for eruption; the shortest interval between exposure and bonding was only 14 weeks. For one of the cases requiring occlusal traction this was due to the failure of natural eruption after an interval of 11 months. For most of the patients where traction was applied to assist eruption orthodontic treatment was already in progress and the procedure was employed to try and reduce the overall duration of appliance therapy; it is not certain whether spontaneous eruption would have occurred in due course had the teeth been left alone. In only one case was assisted eruption initiated because of the perceived risk of mucosal regrowth. In the group with unknown outcome, eruption was seen to be progressing satisfactorily at the time the patient was last examined (except for one case), but none had reached the stage where the result could be definitely recorded.

When considering the radiographic position of the impacted canines there were statistically significant differences between the groups and, as mentioned previously,

the numbers of teeth in 'good' positions were still in a minority even for the successful cases. The radiographic position may therefore be of limited value in predicting the behaviour of the canine following exposure. Figure 2 shows some of the variations in horizontal and vertical position that may be encountered. Similarly, the success or otherwise or eruption did not seem to be age related (at least within the age range of the sample), as the mean ages of the groups were not significantly different.

FIG. 2 Variations in canine radiographic position. (a) Vertical position fair, but horizontal position poor. This is the radiograph of the patient shown in Fig. 1. (b) For the upper right canine, the vertical position was good and the horizontal position fair; this tooth was exposed, subsequently erupted and was aligned orthodontically. The left canine was in a good position both horizontally and vertically, and erupted simply following the extraction of the deciduous tooth. (c) This canine was in a poor position in both the horizontal and vertical planes; nevertheless, it erupted after exposure, although the patient subsequently discontinued treatment.

Direct comparison with alternative techniques is difficult. Had orthodontically-induced eruption been the method under investigation and used on all the patients in this survey then the theoretical success rate (at least for those with known outcomes) should have been 95 per cent. However, in that sense, the patients in which assisted eruption was employed as a secondary procedure fared no worse, in terms of eventual outcome, than if it had been the method of first choice. Only the 5 per cent of cases needing re-exposure would then be classed as total failures. It could be argued that bonding or cementing an attachment at the time of surgery might have prevented the need for re-exposure in these patients. It is unlikely that this would have been feasible without modifications to the surgical technique, as it would probably have been necessary to raise a full palatal flap to facilitate access and achieve adequate moisture control to permit bonding. This, in turn, makes it less likely that the majority of the procedures could have been accomplished under local anaesthesia. McDonald and Yap (1986) described a series of patients who had undergone exposure with the placing of attachments and flap replacement followed by immediate traction. Even then some cases (5/44 teeth, 11·4 per cent) required a further surgical procedure during treatment. Exposure followed by spontaneous eruption appears to be at least as effective as the method they described in terms of the likely need for additional operative procedures. Clark (1971) stated that free physiological eruption was a completely reliable procedure, based on a survey of 2000 cases. The method of exposure employed, however, was radically different involving partial luxation of teeth to disimpact them and the placement of polycarbonate crowns to inhibit soft tissue regrowth.

As stated above, the particular surgical technique and method of packing described in this paper had been applied to a consecutive series of patients with all the procedures undertaken by one operator (JWF), and was selected on the basis of simplicity and greater acceptability under local anaesthesia. However, both authors have been involved in the care of patients treated by alternative methods, including those where a full palatal flap has been raised and then replaced after excision of a wedge of tissue at the flap margin to leave the canine uncovered. Different packing materials (normally Whitehead's varnish on ribbon gauze) have also been used by the surgeons responsible. Spontaneous eruption has generally been noted for these cases as well, with re-exposure being required in isolated instances. This suggests that similar outcomes can be anticipated even with variations in surgical technique and packing methods; indeed, Barricaid is no longer available in the UK except by special order. Apart from Whitehead's varnish on ribbon gauze, other packing materials which can be used include conventional two-paste periodontal dressing (Rayne, 1969) and cotton wool impregnated with zinc oxide and eugenol paste (Howe, 1985).

Regardless of the actual method employed, it is advisable to review patients 2–3 weeks after pack removal, as by then one can make a reasonable assumption as to whether the teeth can be left to erupt or whether other procedures need

to be undertaken. These could include a further review, or bonding an attachment to the exposed palatal surface of the canine to inhibit further soft tissue ingrowth in cases of significant doubt. Alternatively, the enamel can be etched and a quantity of light-cured adhesive of suitable consistency (*Heliosit Orthodontic: Vivadent, FL-9494, Schaan/Liechtenstein*) applied to it directly using a flat plastic instrument. This technique can be used even if the amount of visible enamel is too small to allow a bracket to be placed with ease, especially if the exposure cavity is fairly deep. The composite 'plug' thus formed is effective in preventing further shrinkage of the cavity margins and can be left *in situ* until the operator is confident that eruption is occurring. Even for those teeth that eventually required palatal brackets for occlusal traction, the time interval between exposure and attachment bonding suggests that the risk of coverage of the crown to the extent that bonding is impossible is very low.

It must be emphasized that this study has only addressed one aspect of the overall management of palatally displaced canines, namely a specific outcome measure related to the surgery. As some patients subsequently decided against proceeding with appliance therapy or were lost to follow-up these might be regarded as failed cases even if canine eruption had occurred. This could conceivably be less of a problem if arrangements were made to commence traction shortly after surgery, rather than waiting for eruption. However, this approach would necessitate earlier appliance placement, resulting in prolongation of the active treatment time. The potential problem of discontinuation may be more appropriately addressed by improved pretreatment counselling and more rigorous patient selection.

Conclusions

1. The results of this investigation suggest that excisional exposure permitting free eruption of palatally displaced maxillary canines is successful in the great majority of cases. The initial attachments can then be placed on the buccal aspect of the crown to allow orthodontic forces to be applied to that area.
2. Even when the procedure is only partially successful sufficient tooth substance usually remains exposed to allow bracket bonding to the palatal surface which will then facilitate assisted eruption prior to buccal movement. Total failure of the exposure is fairly rare.
3. With a suitable exposure technique there would seem to be little indication for bonding brackets at the time of surgery, assuming that the intention is to leave the crown exposed. It is strongly advised that all patients be reviewed 2–3 weeks after surgical pack removal; if there is any doubt about the risk of soft tissue coverage then further measures can be undertaken to inhibit this.

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