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EVALUATION OF THE PERIODONTAL STATUS OF PALATALLY IMPACTED MAXILLARY CANINES AFTER EXPOSURE USING A MODIFIED WINDOW TECHNIQUE

Aim: *To evaluate the periodontal status of surgically exposed maxillary canines after their alignment.* ***Patients and Methods:*** *Twenty consecutive patients with one palatally impacted maxillary canine and one fully erupted synergist were selected. The impacted canines were surgically exposed with a modified window technique, an attachment was bonded, and the teeth were extruded and aligned. Six months after therapy, the periodontal status of both canines was evaluated by registering the following parameters:* (1) *keratinized gingiva level,* (2) *attached gingiva level,* (3) *sulcus probing depth,* (4) *length of clinical crown,* (5) *quality of marginal tissue,* (6) *bleeding on probing, and* (7) *height of alveolar bone. The data were analyzed with the Mann-Whitney test.* ***Results:*** *There was no significant difference between the periodontal status of the two canine groups concerning the keratinized gingival level, the attached gingival level, the sulcus probing depth, and the length of the clinical crown. The quality of marginal tissue and bleeding on probing were acceptable. However, the level of alveolar bone was significantly lower in the surgically exposed group.* ***Conclusion:*** *The periodontal health of impacted maxillary canines that were exposed using a modified window technique and subsequently orthodontically aligned is acceptable. The only concern is a somewhat reduced alveolar bone level.* World J Orthod 2009;10:295–300.

Key words: *alveolar bone level, canine exposure, impacted canines, keratinized gingiva, marginal tissue*

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The canine is vital for esthetics, continuity within the dental arch, and function. Palatally impacted maxillary canines are a dilemma for the patient, as well as for the orthodontist. To expose them, the oral surgeon, orthodontist, and periodontist should choose a safe procedure that results in a healthy periodontium. If not aligned, an impacted canine can cause root resorption of adjacent teeth, a compromised occlusion, and an unpleasant appearance.[1–9] Rarely, the crown of the impacted canine itself may be resorbed.[10]

After the third molar, the maxillary canine is the most frequently impacted tooth.[11] Nearly 2% of the patients who are referred for orthodontic treatment have an impacted canine.[6,12–14] Maxillary canines are impacted 10 times as often as their mandibular counterparts. It also appears that females face with this problem more frequently than males.[5,11,15–17] The general consensus is that maxillary canines are 2 to 12 times more palatally impacted than buccally.[11,18]

The etiology of maxillary canine impaction is obscure.[5] However, at least 16 factors are reported as potential causes.[3,5,16,17,19–25] A few of these are heredity, insufficient space, ankylosis, trauma, cysts, and supernumerary teeth. In case of space deficiency, it must be determined whether any teeth (first premolars) should be removed.[19,24]

Early diagnosis (between 9 and 10 years of age) is possible by palpating the maxilla palatally. According to Ericson and Kurol,[26] 5% of 10- to 11-year-old children have nonpalpable unerupted canines. The impaction site can be localized radiographically with Clark's principle.[6,27] Recently, Faber et al[28] recommended computed tomography with rapid prototyping to improve diagnosis and treatment planning. Even more highly recommended is digital volumetric tomography.[25] It must be mentioned that the prognosis of impacted canines worsens with age.[29] The duration of treatment is influenced by factors such as depth of impaction, patient age, and angle of the tooth's long axis to the occlusal plane.[30] Because of possible complications, timely diagnosis and treatment is strongly recommended.

Treatment

Generally, four treatment options exist for impacted teeth: observation, intervention, relocation, or extraction.[31] Occasionally, impacted canines erupt spontaneously. More often, however, surgery is required. If intervention is indicated, surgical exposure and orthodontic treatment are two viable choices.[13,32–34] The type of surgical procedure is particularly decisive for periodontal health after treatment completion. The surgery is not simple and increases the length of treatment.[16,21,35,36] Surgery becomes even more complicated if the patient is missing any permanent teeth or if he has an Angle Class III.[37,38]

Boyd[39] introduced the window technique for labially impacted canines. In its modified form, it involves the least possible tissue excision to provide enough access for bonding an attachment.

Various methods for ligation and orthodontic extrusion are proposed in the relevant literature.[40] Originally, banding of the impacted tooth was recommended.[24,41] Other outdated methods include lasso ligation, cementing a pin into the crown, and ligating or cementing a custom-cast gold cap onto the tooth. These procedures are replaced by bonding buttons or others onto the respective tooth.[11,24,41,42] According to Boyd,[42] direct bonding guarantees the best success for the orthodontic management of palatally exposed canines. Despite all efforts, the prognosis of impacted canines is sometimes poor, meaning they must be removed.[49]

It is of fundamental importance at the completion of treatment that the originally impacted canine is periodontally healthy compared to a normally erupted canine. This investigation was designed to find a response to this issue.

PATIENTS AND METHODS

Twenty patients, 10 males (mean age 16.4 ± 2.5 years, range 13 to 20 years) and 10 females (mean age 17.0 ± 1.2 years, range 15 to 18 years) (total mean age 16.7 ± 1.9 years) were included in this study. All had unilaterally a palatally impacted maxillary canine and a normally erupted synergistic canine. Palatal impaction was verified using Clark's principle. Inclusion criteria were no history of orofacial trauma, no systemic diseases, no congenital disorders, no prepubertal periodontitis, no mental retardation, and no consumption of any gingival hyperplasia (inducing medications such as carbamezapines, phenitoines, and cyclosporine A).

Prior to surgery, all patients were bracketed and banded. If the patient presented with insufficient space in the dental arch, expansion or premolar extraction was initiated. Surgical crown exposure of the impacted tooth was performed with a modified window technique (Fig 1). It was limited to expose only 4 to 5 mm of the crown to preserve the gingival tissue and supporting bone. An advantage of this approach is that it results in less postoperative discomfort for the patient.

The modified window technique begins with the use of a no. 15 scalpel to excise

Fig 1 (left) Intraoral situation after dressing removal. Note minimum crown exposure with almost no inflammation. Molars were previously banded.

Fig 2 (right) Situation after completed bonding procedure.

Fig 3 (a) Initial distal traction with power chain—the crown of the previously impacted canine is close to the lateral incisor; **(b)** situation 4 months later.

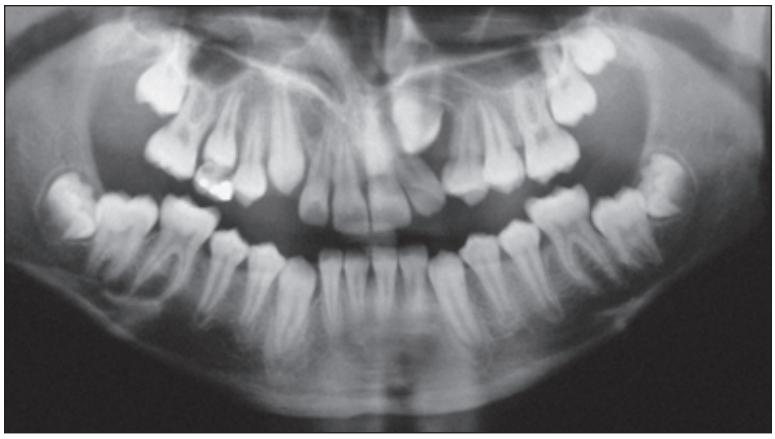

Fig 4 Panoramic radiograph of a 16-year-old patient with a palatally impacted maxillary left canine. Note the distally tipped crown of the lateral incisor due to the anteriorly positioned canine crown.

the soft tissue covering the crown of the palatally impacted canine. The incision is limited to the area needed to attach a button or cleat. Any bone is removed with a chisel or no. 2 round diamond bur. The incised gingival edges are beveled to prevent their proliferation into the exposure site, which is then compressed with wet gauze for 10 minutes to control bleeding. The procedure concludes with a Co-Pack surgical dressing stabilized with a few sutures.

Occasionally bleeding may be controlled with electrosurgical coagulation. In case of postsurgical discomfort, over-the-counter analgesic medication can help. Patients should rinse with 0.2% chlorhexidine solution for 2 weeks following surgery. After 1 week, the dressing is removed and the site professionally cleaned with physiologic saline. The patient is also instructed to gently clean the exposed location with a soft brush. During the second week, the patient is referred for bonding an attachment to the exposed enamel (Fig 2).

At the same time, the remaining teeth are bracketed. If the canine is close to the lateral incisor root, it will initially be pulled distally with a power chain before it is tied with elastic thread to the archwire (Fig 3).[16,18,24,33,49] Panoramic radiographs will help define the direction of traction (Fig 4). During active orthodontic

Table 1 Periodontal status of the two groups of teeth (in mm)

Parameter	Normal (mean ± SD)	Impacted (mean ± SD)	*P*
Gingival sulcus (DB)	2.3 ± 0.7	2.3 ± 0.5	≤ .9
Gingival sulcus (MB)	2.5 ± 1.2	2.7 ± 1.3	≤ .7
Gingival sulcus (midB)	1.9 ± 1.2	1.8 ± 0.9	≤ 1.0
Gingival sulcus (L)	2.4 ± 0.7	2.5 ± 0.9	≤ .8
Length of clinical crown	9.3 ± 1.7	9.9 ± 1.6	≤ .5
Keratinized gingiva level	5.0 ± 1.4	4.5 ± 1.4	≤ .4
Attached gingiva level	3.2 ± 1.1	2.6 ± 0.7	≤ .2

SD = standard deviation; DB = distobuccal; MB = mesiobuccal; midB = midbuccal; L= lingual.

therapy, the patient is recalled every 3 to 5 months for professional periodontal maintenance therapy.[43]

The periodontal status of both maxillary canines was evaluated 6 months after therapy. The evaluation included registration of *(1)* keratinized gingiva level, *(2)* attached gingiva level, *(3)* sulcus probing depth, *(4)* length of clinical crown, *(5)* quality of marginal tissue, *(6)* bleeding on probing, and *(7)* height of the alveolar bone.[44]

All examinations were performed with a Williams periodontal probe by one dentist under the supervision of a periodontist. To evaluate the bone level, the distance between the cementoenamel junction and the alveolar bone crest was measured. The length of the clinical crown was computed buccally with a Vernier digital caliper as the distance between the deepest curvature of the gingival margin and the canine cusp tip.

Bleeding on probing is categorized in six levels[44]:

0 Healthy gingiva, no bleeding on probing
1 Healthy gingiva, but bleeding on probing
2 Altered gingiva color and bleeding on probing
3 Altered gingiva color, slightly edematous, and bleeding on probing
4 Altered gingiva color, greatly edematous, and bleeding on probing
5 Altered gingiva color, greatly edematous, and self-bleeding

The Mann-Whitney test was used to compare the two groups of teeth (normally erupted vs orthodontically erupted) for their periodontal condition.

RESULTS

The quality of the gingival margin was acceptable in 16 patients but unacceptable in the remaining four. The Bleeding Index was 0 in 12 and 1 in eight individuals.

The remaining results are listed in Table 1. The clinical crown length ranged between 5.4 and 12.0 mm in the control group (9.3 ± 1.7 mm) and from 6.7 to 12.0 mm (9.9 ± 1.6 mm) in the study group ($P \leq .5$). The range of the keratinized gingiva in the control group was from 4.0 to 8.0 mm (5.0 ± 1.4 mm) and from 3.0 to 7.0 mm (4.5 ± 1.4 mm) in the study group ($P \leq .4$). For the level of the attached gingiva the respective values were 2.0 to 5.0 mm (3.2 ± 1.1 mm) in the control group and 2.0 to 4.0 mm (2.6 ± 0.7 mm) in the study group ($P \leq .2$).

The range of the bone level in the control group varied between 0 and 1.0 mm (0.1 ± 0.3 mm) and between 0 and 2.0 mm (1.0 ± 0.5 mm) in the study group ($P \leq .006$).

DISCUSSION

In 1987, Gaulis and Joho[46] studied the periodontal condition of surgically exposed teeth. They found mucogingival problems in the surgically treated teeth, especially when they were impacted vestibularly. A Swedish study concluded similar periodontal conditions on both sides.[9] But even if the periodontal condition of the exposed tooth is unfavorable, it should not be forgotten that the adverse condition can gradually reverse to some degree.[47]

Boyd[39] used a window approach for labially impacted canines, during which the entire crown was exposed. Subsequently, the periodontal condition of the respective teeth after orthodontic treatment was characterized by gingival recessions, inflammation, and attachment loss. These consequences possibly relate to the fact that the entire crown was exposed. Thus, this technique was modified for the present study. Here, a window was created by removing only a very small part of the soft and hard tissue over the crown.

In this investigation, no significant difference was found for the measurements of the keratinized gingiva level, attached gingiva level, sulcus probing depth, length of clinical crown, quality of marginal tissue, and bleeding on probing. If the height of the alveolar bone was 0.9 mm less in the previously impacted teeth, it should be taken into consideration that this deficiency could be substituted with synthetic bone.[35]

The results of this research could only partially be compared to other publications because none evaluated all seven of the aforementioned periodontal factors. D'Amico et al[9] found in their study of unilaterally impacted canines similar periodontal conditions as in normally erupted canines with the exception of sulcus probing depth. According to Kohavi et al,[36] the surgical exposure technique plays an important role to achieve an acceptable alignment with minimal periodontal complications. Their study also indicated that no difference was found between the exposed and control side, except for the loss of bony support.

It should be realized that not all unerupted teeth can be salvaged and that they must be removed in certain situations.[49] In those cases, restorative procedures are an alternative to orthodontic treatment.[50]

The combination of the described surgical technique and orthodontic therapy leads to a successful alignment of impacted canines with sound periodontal conditions.

CONCLUSION

Based upon the results of this study, the periodontal status of impacted maxillary canines that are orthodontically aligned into the dental arch is comparable to routinely treated canines. A modified window technique is superior to surgically expose impacted canines.

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REFERENCES

1. Erikson BE. Impaction and pseudo-impactions of teeth. Am J Orthod 1938;24:1090–1096.
2. Erickson S, Kurol J. Resorption of maxillary lateral incisors caused by ectopic eruption of the canines. A clinical and radiographic analysis of predisposing factors. Am J Orthod Dentofacial Orthop 1988;94:503–513.
3. Proffitt WR. The etiology of orthodontic problems. In: Contemporary Orthodontics. St Louis: Mosby, 1986:95–102.
4. DiSalvo NA. Evaluation of unerupted teeth: Orthodontic viewpoint. J Am Dent Assoc 1971; 82:829–834.
5. Fastlicht S. Treatment of impacted canines. Am J Orthod 1954;40:891–905.
6. Jarjoura K, Crespo P, Fine JB. Maxillary canine impactions: Orthodontic and surgical management. Compend Contin Educ Dent 2002;23: 23–26.
7. Becker A, Chaushu S. Long-term follow-up of severely resorbed maxillary incisors after resolution of an etiologically associated impacted canine. Am J Orthod Dentofacial Orthop 2005; 127:650–654.
8. Otto RL. Early and unusual incisor resorption due to impacted maxillary canines. Am J Orthod Dentofacial Orthop 2003;124:446–449.
9. D'Amico RM, Bjerklin K, Kurol J, Falahat B. Long-term results of orthodontic treatment of impacted maxillary canines. Angle Orthod 2003;73:231–238.
10. Azaz B, Shteyer A. Resorption of the crown in impacted maxillary canine. A clinical, radiographic and histologic study. Int J Oral Surg 1978;7:167–171.
11. Shapira Y, Kuftinec MM. Early diagnosis and interpretation of potential maxillary canine impaction. J Am Dent Assoc 1998;129: 1450–1454.
12. Olive RJ. Orthodontic treatment of palatally impacted maxillary canines. Aust Orthod J 2002; 18:64–70.

13. Sunil S, Avinash BS, Prasad D, Jagadish L. A modified double pedicle graft technique and other mucogingival interceptive surgeries for the management of impacted teeth: A case series. Indian J Dent Res 2006;17:35–39.
14. McDonald F, Yap WL. The surgical exposure and application of direct traction of unerupted teeth. Am J Orthod 1986;89:331–340.
15. Rohrer A. Displaced and impacted canines. Int J Orthod 1929;15:1003–1020.
16. Lappin MM. Practical management of the impacted maxillary cuspid. Am J Orthod 1951; 37:769–778.
17. Gensior AM, Strauss RE. The direct bonding technique applied to the management of the maxillary impacted canine. J Am Dent Assoc 1974;89:1332–1337.
18. Jacoby H. The etiology of maxillary canine impactions. Am J Orthod 1983;84:125–132.
19. Bishara SE, Kommer DD, McNeil MH, Montagano LN, Oesterle LJ, Youngquist HW. Management of impacted canines. Am J Orthod 1976;69:371–387.
20. Ericson S, Kurol J. Radiographic examination of ectopically erupting maxillary canines. Am J Orthod Dentofacial Orthop 1987;91:483–492.
21. Ziegler TF. A modified technique for ligating impacted canines. Am J Orthod 1977;72: 665–670.
22. Levin MP, D'Amico RA. Flap design in exposing unerupted teeth. Am J Orthod 1974;65:419–422.
23. Ericson S, Kurol J. Early treatment of palatally erupting maxillary canines by extraction of the primary canines. Eur J Orthod 1988;10:283–295.
24. Lewis PD. Preorthodontic surgery in the treatment of impacted canines. Am J Orthod 1971; 60:382–397.
25. Becher A. Palatally impacted canine. In: The Orthodontic Treatment of Impacted Teeth, ed 2. Thieme: UK, 2007:93–150.
26. Ericson S, Kurol J. Longitudinal study and analysis of clinical supervision of maxillary canine eruption. Community Dent Oral Epidemiol 1986;14:172–176.
27. Ferguson JW. Management of the unerupted maxillary canine. Br Dent J 1990;169:11–17.
28. Faber J, Berto PM, Quaresma M. Rapid prototyping as a tool for diagnosis and treatment planning for maxillary canine impaction. Am J Orthod Dentofacial Orthop 2006;129:583–589.
29. Becker A, Chaushu S. Success rate and duration of orthodontic treatment for adult patients with palatally impacted maxillary canines. Am J Orthod Dentofacial Orthop 2003;124:509–514.
30. Zuccati G, Ghobadlu J, Nieri M, Clauser C. Factors associated with the duration of forced eruption of impacted maxillary canines: A retrospective study. Am J Orthod Dentofacial Orthop 2006;130:349–356.
31. Frank CA. Treatment options for impacted teeth. J Am Dent Assoc 2000;131:623–632.
32. Frank CA, Long M. Periodontal concerns associated with the orthodontic treatment of impacted teeth. Am J Orthod Dentofacial Orthop 2002;121:639–649.
33. Council on Communications. "Orthodontic Dialogue." The Management of unerupted maxillary cuspid. Am Assoc Orthodontists Publications, 4(2) spring 1992.
34. Lin JJ. Do teeth want to be straight? A nonsurgical approach to unerupted teeth. World J Orthod 2005;6:248–257.
35. Caranza F, Newman M. Clinical Periodontology, ed 8. Philadelphia: Saunders, 1996.
36. Kohavi D, Becker A, Zilberman Y. Surgical exposure, orthodontic movement, and final tooth position as factors in periodontal breakdown of treated palatally impacted canines. Am J Orthod 1984;85:72–77.
37. Arslan SG, Kama JD, Baran S. Correction of a severe Class III malocclusion. Am J Orthod Dentofacial Orthop 2004;126:237–244.
38. Saiar M, Rebellato J. Maxillary impacted canine with congenitally absent premolars. Angle Orthod 2004;74:568–575.
39. Boyd RL. Clinical assessment of injuries in orthodontic movement of impacted teeth. II. Surgical recommendations. Am J Orthod 1984;86: 407–418.
40. Johnston WD. Treatment of palatally impacted canine teeth. Am J Orthod 1969;56:589–596.
41. von der Heydt K. The surgical uncovering and orthodontic positioning of unerupted maxillary canines. Am J Orthod 1975;68:256–276.
42. Boyd RL. Clinical assessment of injuries in orthodontic movement of impacted teeth. I. Methods of attachment. Am J Orthod 1982;82:478–486.
43. Hammerle CHF, Joss A, Lang NP. Short-term effects of initial periodontal therapy (hygienic phase). J Clin Periodontol 1991;18:233–239.
44. Stewart JA, Heo G, Glover KE, Williamson PC, Lam EW, Major PW. Factors that relate to treatment duration for patients with palatally impacted maxillary canines. Am J Orthod Dentofacial Orthop 2001;119:216–225.
45. Zachrisson BV, Alnaes L. Periodontal condition in orthodontically treated and unerupted individuals. 1. Loss of attachment, gingival pocket depth, and clinical crown height. Angle Orthod 1973;43:402–411.
46. Gaulis R, Joho JP. The marginal periodontium of impacted upper canines. Evaluation of following various methods of surgical approach and orthodontic procedures [in French]. SSO Schweiz Monatsschr Zahnheilkd 1978;88:1249–1261.
47. Boyd RL, Leggott PJ, Quinn RS, Eakle WS, Chambers D. Periodontal implications of orthodontic treatment in adults with reduced or normal periodontal tissues versus those of adolescents. Am J Orthod Dentofacial Orthop 1989;96:191–198.
48. Danan M, Zenou S, Bouaziz-Attal AS, Dridi SM. Orthodontic traction of an impacted canine through a synthetic bone substitute. J Clin Orthod 2004;38:39–44.
49. Vanarsdall RL, Corn H. Soft-tissue management of labially positioned unerupted teeth. Am J Orthod 1977;72:53–64.
50. Magheri P, Cambi S, Grandini R. Restorative alternatives for the treatment of an impacted canine: Surgical and prosthetic considerations. Pract Proced Aesthet Dent 2002;14:659–664.