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Original article

Prevalence of impacted maxillary canines—an epidemiological study in a region with systematically implemented interceptive treatment

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Summary

Background: In dentistry, epidemiological studies are important for establishing high-quality care for the individual patient as well as for socio-economic reasons.
Objective: The aim of this epidemiological study was to evaluate the prevalence of impacted maxillary canines in a geographical region in which interceptive treatment is implemented systematically. Furthermore, the aim was to study the age and gender of the patients, and the location and surgical technique used for the impacted maxillary canine.
Method: The study was based on 54 716 adolescents in the Region Västra Götaland, Sweden who were born in the period 1996–98. All patients in the three cohorts who had impacted maxillary canines treated with surgical exposure or surgical removal were identified in the dental record system used in the region.
Results: The prevalence of impacted maxillary canines when interceptive treatment was systematically implemented was 1.1% (*N* = 601). Overall, the cohorts of patients with impacted canines comprised 65% girls and 35% boys. Most of the canines were palatally impacted and the most common surgical technique was closed exposure.
Conclusion: The prevalence of impacted maxillary canines in a geographical area in which interceptive treatment is systematically implemented is lower than that reported previously. The distributions of impacted canines with respect to gender and location are in accordance with those reported previously in similar studies.

Introduction

Dental impaction occurs when a tooth remains embedded in the alveolar bone and fails to erupt into the oral cavity at the expected time (1). An impacted tooth may be located in a correct or displaced position, whereas an ectopic tooth is always displaced. Severely ectopic teeth can be predicted to become impacted, even though the expected developmental window has not yet passed. Maxillary canines are the teeth with the longest and most complicated eruption pathway (2, 3), and are the second-most-prone teeth to become impacted (4–6). The prevalence of impacted maxillary canines has been reported to be in the range of 1.7–4.7% (Table 1) (7–10). They occur more frequently in females than in males (10–13), and impaction is observed more often in the maxilla than in the mandible (4, 12, 14).

Table 1. Previous studies on the prevalence of impacted maxillary canines based on a sample representative of the entire population.

Author and year	Country	Sample size (*N*)	Patients with impacted maxillary canines (*N*)	Impacted maxillary canines (*n*)	Prevalence patient level (%)	Prevalence tooth level (%)
Dachi and Howell (1961) (29)	USA	3043		28		0.92
Thilander and Jakobsson (1968) (7)	Sweden	384	7	10	1.8	
Ericson and Kurol (1986) (8)	Sweden	505		15		1.7
Prskalo *et al.* (2008) (9)	Croatia	170	8		4.7	
Aktan *et al.* (2010) (10)	Turkey	5000	87	110	1.7	
Lövgren *et al.* (2019)	Sweden	54 716	601	724	1.1	

Impacted maxillary canines are more frequently palatally positioned than buccally positioned (8). Furthermore, unilateral impacted maxillary canines are more common than bilateral impacted canines (13, 15).

While the aetiology of canine impaction is currently unknown, various factors, mainly genetic and local, have been considered (1, 7, 11, 16–20). In our recently published study, various clinical factors that are potentially implicated in tooth impaction were investigated in a multivariate analysis. However, no factors were identified that could be used to predict impaction of the maxillary canines (21). The crucial requirement of the dental follicle for the tooth eruption process has been demonstrated (22–24).

The importance of early diagnosis of ectopic maxillary canines is essential for prompt application of an adequate treatment, especially for the palatally positioned teeth. This is the case because spontaneous correction of a palatal ectopic canine occurs in two-thirds of cases if interceptive treatment is initiated and the deciduous tooth is extracted on time (25). The success rate for interceptive treatment decreases with patient age (26). Early and accurate diagnosis, followed by the appropriate interceptive treatment is important, not only to prevent the risk of impaction, but also to prevent resorption of the adjacent teeth (27).

At the Public Dental Service in the Region Västra Götaland (VGR), which is the largest dental organization in Sweden, systematically implemented interceptive treatment with extraction of the deciduous canine and accurate monitoring according to the recommendations (25, 28), is performed on all patients with ectopic maxillary canines. The organization is uniquely suited to the carrying out of epidemiological studies, not only because regular dental examinations and dental care are provided free of charge to all children and adolescents in the area, but also because of the existence of a common dental record system for documentation, which facilitates data and information extraction and analysis. Previous studies (25, 28) have demonstrated that extraction of the deciduous canine promotes spontaneous eruption of the ectopic permanent canine in controlled experimental settings. However, to date, no study has presented epidemiological data regarding systematically implemented interceptive treatment. Therefore, the aim of the present study was to determine the prevalence of impacted maxillary canines in a region in which interceptive treatment is systematically implemented. An additional aim was to study the age and gender of the patients, and the location and surgical procedure for the impacted maxillary canine.

Subjects and methods

Study design

The study, which has a retrospective longitudinal design, was approved by the Regional Ethics Board at the University of Gothenburg, Sweden (Dnr. 898-13).

Table 2. Distributions of year of birth and year when patients underwent surgical removal or surgical exposure of an impacted maxillary canine.

Cohort	Year of birth	Data extraction period	Registered patients (*N*)	Included patients (*N*)	Prevalence of impacted maxillary canines (%)
1	1996	2005–15	18 341	201	1.1
2	1997	2006–16	18 030	188	1.0
3	1998	2007–17	18 345	212	1.2
Total			54 716	601	1.1

Data collection procedure

The study involved 54 716 adolescents in the VGR who were born in the period 1996–98 and who at the age of 19 years or younger underwent surgical exposure or surgical removal of an impacted maxillary canine. A surgical exposure or removal was performed on a maxillary canine which were considered impacted or had a severely ectopic position, and thus a risk of becoming impacted. The patients in the three cohorts (born in 1996, 1997, or 1998) with impacted teeth were identified in the common digital dental record system (T4) by screening for procedure codes for surgical exposure or surgical removal. The dental records of the identified patients were then further screened for the following items of information:

- Age at surgery
- Gender
- Unilateral or bilateral impaction
- Position of the impacted canine (palatal/central/buccal)
- Surgical technique (open exposure/closed exposure/surgical removal)
- Interceptive treatment (persisting/absent deciduous tooth)
- Age at interceptive treatment

The position of the canine was determined by radiographs and the recorded notes of the surgeon.

Statistical analysis

The data were archived and analysed with the MS Excel ver. 2017 software (Microsoft Corporation, Redmond, Washington, USA). Descriptive statistics were applied, including mean and standard deviations, to establish the prevalence of impacted maxillary canines. Furthermore, the distribution of age, gender, positions of the tooth, surgical technique, etc. were analysed. The prevalence was calculated as the proportion of the population that had undergone a surgical exposure or removal.

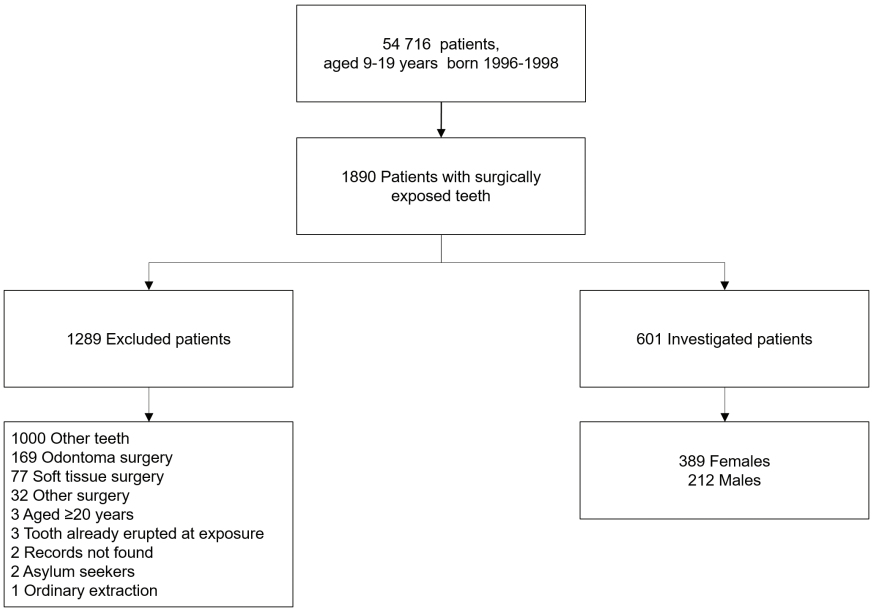

Figure 1. Flow chart showing the patients who were excluded and included in the study.

Results

Among the 54 716 adolescents in this study, 601 had impacted maxillary canines, giving a prevalence of 1.1%. The data were consistent for all three cohorts (patients born 1996–98) (Table 2). For the overall study cohort, the mean age at surgery was 14.6 ± 1.9 years (range, 9.6–19.9 years), and there was no difference with respect to the position of the impacted maxillary canine. More females than males had impacted canines [65% (N = 389) versus 35% (N = 212), respectively] (Figure 1). Of the 601 subjects who had impacted maxillary canines, 20% (N = 123) had bilateral impacted maxillary canines. Of the 724 teeth examined, 61% were positioned palatally, 27% buccally, and 12% centrally.

The majority of the impacted maxillary canines were surgically exposed with a closed procedure. Centrally positioned canines were usually treated with an open or closed exposure. Buccally positioned canines were removed more frequently than centrally or palatally positioned canines (Table 3). The proportion of impacted canines that underwent surgical removal was higher for subjects in the age range of 18–19 years (Figure 2).

Interceptive treatment was performed on 81% of the patients with palatally ectopic canines (Table 4). The mean age at the time of extraction of the deciduous canine for patients with a palatally positioned maxillary canine was 12.6 ± 2.0 years (Table 5). The patients with palatally positioned canines who had received interceptive treatment, underwent surgical removal or exposure at an earlier age than the patients who did not receive interceptive treatment.

Table 3. Distributions of surgery technique and position of the impacted maxillary canine as proportions of the total number of impacted canines.

	Position of canine, N (%)			
Surgical technique	Palatal	Central	Buccal	Overall (%)
Surgical removal	69 (10)	9 (1)	66 (9)	144 (20)
Open exposure	135 (19)	40 (6)	26 (4)	201 (28)
Closed exposure	236 (33)	39 (5)	104 (14)	379 (52)
Total	440 (61)	88 (12)	196 (27)	724 (100)

Discussion

In the present study, the prevalence of impacted canines in a geographical region with systematically implemented interceptive treatment was found to be 1.1%. Only a minor difference in prevalence was observed across the three cohorts thereby representing a reliable result. Previous studies based on a Swedish population in which there was no systematic implementation of interceptive treatment reported prevalence in the range of 1.7–1.8% (7, 8). This 40% difference in prevalence indicates that most of the patients with ectopic eruption of the maxillary canine have been diagnosed and have received systematically implemented interceptive treatment with successful outcome.

Epidemiological studies that include a representative study sample are difficult to perform. Only a few studies have presented data on the prevalence of impacted maxillary canines based on a representative sample of the overall population (Table 1) (7–10, 29). Several studies have based their epidemiological data on groups that constitute biased samples, i.e. patients who are registered at an orthodontic clinic or similar facility, resulting in a prevalence that is higher than if the sample had been based on a more representative fraction of the population. Other studies have calculated the proportion of impacted maxillary canines in relation to other impacted teeth, which does not produce a prevalence value for the population. In Sweden, regular dental visits are free of charge for all children and for adolescents up to the age of 23 years. Since healthcare is the responsibility of a single organization in the county, it is possible to conduct studies in which the entire population is represented.

The available epidemiological data on impacted maxillary canines have not been analysed since 1986 (8), so they may be out of date, given that societal diversity has increased in the interim period.

Figure 2. Distribution of age of the patients included in the study with respect to the surgical technique applied to the impacted maxillary canine.

Table 4. Distributions of patients who received or did not receive interceptive treatment in relation to the position of the impacted maxillary canine.

	Position of canine (%)			
	Palatal	Central	Buccal	Overall
Interceptive treatment	81	89	83	82%
No interceptive treatment	19	11	17	18%

This suggests that the prevalence data before interceptive treatment need to be updated. However, with our current knowledge of the importance of interceptive treatment, it is not ethical to postpone interceptive treatment due to the risks discussed earlier.

The distribution of impacted maxillary canines across genders in the present study was approximately 1.8:1.0 in favour of females, which is consistent with the results of earlier studies (7, 10, 13). In the present study, the majority of the impacted canines were unilateral and located palatally, which is also in agreement with previous studies (8, 13).

Most of the palatally and buccally positioned maxillary canines were treated with a closed surgical exposure, which may reflect a desire to align the canine into the arch directly. Half of the centrally positioned canines were treated with an open exposure technique, probably due to their already correct positioning in the sagittal plane, and the possibility to minimize the time required with fixed appliance.

Surgical removal of impacted maxillary canines could be the result of unfavourable positioning, insufficient space in the dental arch, inadequate oral hygiene, or patients having disabilities or lacking interest in the treatment. Thus, surgical exposure with the requisite subsequent treatment with a fixed appliance is unsuitable. Surgical removal of the impacted canine was over-represented among the subjects with buccally positioned maxillary canines. The high frequency of removal might be because buccally impacted canines are associated with a high risk of causing damage to the roots of the lateral incisors during orthodontic extrusion. Another reason for the high frequency of removal of buccally placed canines may be space insufficiency, which has been reported as being more common among buccally placed canines than among palatally placed canines (16, 30). A higher proportion of surgical removals of impacted maxillary canines was observed in subjects in the age range of 17–18 years. This may be because the success rate decreases and duration of treatment increases with age (26).

In a majority of the patients with palatal ectopic maxillary canines, the deciduous tooth was absent at the time of surgery, meaning that interceptive treatment had been implemented. The mean age for the patients who received interceptive treatment was 12.6 years, which is in accordance with current recommendations (28). Patients with centrally and buccally placed canines with risk of becoming impacted received interceptive treatment despite the lack of generally accepted guidelines for centrally and buccally canine impaction. A possible explanation for this finding is that the permanent canine initially had a palatal position which improved to a buccal or central position after the interceptive treatment.

In almost 20% of the patients with palatally located maxillary canines, the deciduous canine was still present at the time of surgery. The deciduous tooth might persist as a space holder until implant installation after surgical removal of the permanent canine. Alternatively, the deciduous tooth might persist as a consequence of prompt, early surgery to prevent ongoing root resorption of the adjacent teeth, allowing no time for interceptive treatment. A persisting deciduous canine might also be due to the fact that the ectopic tooth has been over-looked and that no interceptive extraction has been performed. The mean age for surgery was higher in the patients with persisting deciduous canines than in the patients with extracted or exfoliated deciduous canines. Delayed treatment due to non-implementation of interceptive treatment may be attributable to factors related to the patient or the routines of the care provider.

In an ideal system with optimal implementation of interceptive treatment, an even lower prevalence of impacted maxillary canines might be possible. However, as not all impacted maxillary canines erupt despite interceptive treatment (25), achieving a prevalence of zero is not possible. However, considering the burden on the affected patients, an extra effort should be made to ensure early diagnosis of impacted canines in all patients. The present study establishes a prevalence for impacted maxillary canines in an area with systematically implemented interceptive treatment, and this could be useful not only as the basis for comparison in other epidemiological studies but also as the baseline for future, systematic quality work in dental organizations.

Table 5. Distributions of the positioning of the impacted maxillary canine in relation to the mean age at interceptive treatment and at surgical exposure or removal.

	Position			
	Palatal	Central	Buccal	Overall
Mean age at interceptive treatment (years)	12.6 ± 2.0	12.6 ± 2.1	11.9 ± 2.0	12.4 ± 2.1
Mean age at surgical exposure/removal (years)				
Patients who received interceptive treatment	14.5 ± 1.7	15.1 ± 2.1	14.4 ± 2.1	14.6 ± 1.9
Patients who did not receive interceptive treatment	15.8 ± 2.1	13.9 ± 2.8	13.6 ± 1.6	14.8 ± 2.1

Conclusion

The prevalence of impacted maxillary canines in a geographical area in which interceptive treatment is systematically implemented is lower than that reported earlier. The distributions of the impacted canines across gender and location are in accordance with those reported in previous studies.

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Conflicts of interest

None to declare.

References

1. Litsas, G. and Acar, A. (2011) A review of early displaced maxillary canines: etiology, diagnosis and interceptive treatment. *The Open Dentistry Journal,* 5, 39–47.
2. Dewel, B. (1949) The upper cuspid: it's development and impaction. *The Angle Orthodontist*, 19, 79–90.
3. Lappin, M.M. (1951) Practical management of the impacted maxillary cuspid. *American Journal of Orthodontics,* 37, 769–778.
4. Grover, P.S. and Lorton, L. (1985) The incidence of unerupted permanent teeth and related clinical cases. *Oral Surgery, Oral Medicine, and Oral Pathology,* 59, 420–425.
5. Chu, F.C., Li, T.K., Lui, V.K., Newsome, P.R., Chow, R.L. and Cheung, L.K. (2003) Prevalence of impacted teeth and associated pathologies–a radiographic study of the Hong Kong Chinese population. *Hong Kong Medical Journal,* 9, 158–163.
6. Pedro, F.L., Bandéca, M.C., Volpato, L.E., Marques, A.T., Borba, A.M., Musis, C.R. and Borges, A.H. (2014) Prevalence of impacted teeth in a Brazilian subpopulation. *The Journal of Contemporary Dental Practice,* 15, 209–213.
7. Thilander, B. and Jakobsson, S.O. (1968) Local factors in impaction of maxillary canines. *Acta Odontologica Scandinavica,* 26, 145–168.
8. Ericson, S. and Kurol, J. (1986) Radiographic assessment of maxillary canine eruption in children with clinical signs of eruption disturbance. *European Journal of Orthodontics,* 8, 133–140.
9. Prskalo, K., Zjaca, K., Skarić-Jurić, T., Nikolić, I., Anić-Milosević, S. and Lauc, T. (2008) The prevalence of lateral incisor hypodontia and canine impaction in Croatian population. *Collegium Antropologicum,* 32, 1105–1109.
10. Aktan, A.M., Kara, S., Akgünlü, F. and Malkoç, S. (2010) The incidence of canine transmigration and tooth impaction in a Turkish subpopulation. *European Journal of Orthodontics,* 32, 575–581.
11. Becker, A., Smith, P. and Behar, R. (1981) The incidence of anomalous maxillary lateral incisors in relation to palatally-displaced cuspids. *The Angle Orthodontist,* 51, 24–29.
12. Fardi, A., Kondylidou-Sidira, A., Bachour, Z., Parisis, N. and Tsirlis, A. (2011) Incidence of impacted and supernumerary teeth-a radiographic study in a North Greek population. *Medicina Oral, Patologia Oral y Cirugia Bucal,* 16, e56–e61.
13. Herrera-Atoche, J.R., Agüayo-de-Pau, M.D., Escoffié-Ramírez, M., Aguilar-Ayala, F.J., Carrillo-Ávila, B.A. and Rejón-Peraza, M.E. (2017) Impacted maxillary canine prevalence and its association with other dental anomalies in a Mexican population. *International Journal of Dentistry,* 2017, 7326061.
14. Aydin, U., Yilmaz, H.H. and Yildirim, D. (2004) Incidence of canine impaction and transmigration in a patient population. *Dento Maxillo Facial Radiology,* 33, 164–169.
15. Sajnani, A.K. and King, N.M. (2014) Prevalence and characteristics of impacted maxillary canines in Southern Chinese children and adolescents. *Journal of Investigative and Clinical Dentistry,* 5, 38–44.
16. Jacoby, H. (1983) The etiology of maxillary canine impactions. *American Journal of Orthodontics,* 84, 125–132.
17. Bishara, S.E. (1992) Impacted maxillary canines: a review. *American Journal of Orthodontics and Dentofacial Orthopedics,* 101, 159–171.
18. Peck, S., Peck, L. and Kataja, M. (1994) The palatally displaced canine as a dental anomaly of genetic origin. *The Angle Orthodontist,* 64, 249–256.
19. Sacerdoti, R. and Baccetti, T. (2004) Dentoskeletal features associated with unilateral or bilateral palatal displacement of maxillary canines. *The Angle Orthodontist,* 74, 725–732.
20. Brin, I., Becker, A. and Shalhav, M. (1986) Position of the maxillary permanent canine in relation to anomalous or missing lateral incisors: a population study. *European Journal of Orthodontics,* 8, 12–16.
21. Uribe, P., Ransjö, M. and Westerlund, A. (2017) Clinical predictors of maxillary canine impaction: a novel approach using multivariate analysis. *European Journal of Orthodontics,* 39, 153–160.
22. Cahill, D.R. and Marks, S.C. Jr. (1980) Tooth eruption: evidence for the central role of the dental follicle. *Journal of Oral Pathology,* 9, 189–200.
23. Marks, S.C. Jr and Cahill, D.R. (1984) Experimental study in the dog of the non-active role of the tooth in the eruptive process. *Archives of Oral Biology,* 29, 311–322.
24. Wise, G.E. (2009) Cellular and molecular basis of tooth eruption. *Orthodontics & Craniofacial Research,* 12, 67–73.
25. Naoumova, J., Kurol, J. and Kjellberg, H. (2015) Extraction of the deciduous canine as an interceptive treatment in children with palatal dis-

placed canines - part I: shall we extract the deciduous canine or not? *European Journal of Orthodontics,* 37, 209–218.
26. Becker, A. and Chaushu, S. (2003) Success rate and duration of orthodontic treatment for adult patients with palatally impacted maxillary canines. *American Journal of Orthodontics and Dentofacial Orthopedics,* 124, 509–514.
27. Yan, B., Sun, Z., Fields, H. and Wang, L. (2012) Maxillary canine impaction increases root resorption risk of adjacent teeth: a problem of physical proximity. *American Journal of Orthodontics and Dentofacial Orthopedics,* 142, 750–757.
28. Ericson, S. and Kurol, J. (1988) Early treatment of palatally erupting maxillary canines by extraction of the primary canines. *European Journal of Orthodontics,* 10, 283–295.
29. Dachi, S.F. and Howell, F.V. (1961) A survey of 3, 874 routine full-month radiographs. II. A study of impacted teeth. *Oral Surgery, Oral Medicine, and Oral Pathology,* 14, 1165–1169.
30. Yan, B., Sun, Z., Fields, H., Wang, L. and Luo, L. (2013) Etiologic factors for buccal and palatal maxillary canine impaction: a perspective based on cone-beam computed tomography analyses. *American Journal of Orthodontics and Dentofacial Orthopedics,* 143, 527–534.