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Maxillary Transverse Discrepancies and Potentially Impacted Maxillary Canines in Mixed-dentition Patients

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ABSTRACT

Objective: To investigate the correlation between maxillary transverse discrepancy and the occurrence of impacted canines in patients during the mixed-dentition stage.

Materials and Methods: Panoramic radiographs and dental casts were evaluated of randomly selected patients in the mixed dentition. The experimental group consisted of 84 orthodontic patients with a maxillary transverse discrepancy. The control group included 100 orthodontic patients without a maxillary transverse discrepancy. Intermolar widths of the experimental group were measured and recorded. The permanent canines of both groups were placed into a sector classification by using a panoramic radiograph. The experimental group was then analyzed to identify whether these patients had an impacted maxillary canine associated with the transverse discrepancy. The results were further evaluated based on type of impaction (unilateral or bilateral).

Results: Results of this study showed that patients with a transverse discrepancy are more likely to have an impacted canine than those patients without a transverse discrepancy, with the impaction more likely being unilateral. However, patients with a transverse discrepancy do not have a greater likelihood of having a bilateral impaction compared with patients without a transverse discrepancy.

Conclusions: There appears to be an association between potentially impacted canines and transverse discrepancies. Identification can be made early based on proper panoramic evaluation and clinical detection. If a possibly impacted canine is detected early, appropriate treatment should be taken to minimize complications and avoid definitive impaction.

KEY WORDS: Impacted canine, Transverse discrepancy, Crossbite, Mixed dentition.

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INTRODUCTION Return to TOC

Ectopic eruption and impaction of the maxillary canine are frequent anomalies. After the third molar, the maxillary canine is the most frequently impacted tooth in the dental arch.[1–5] The incidence of maxillary canine impaction has been reported as involving approximately

2% of the patients seeking orthodontic treatment.[1,6] Maxillary canines are 10 to 20 times more commonly impacted than mandibular canines.[7,8] Palatal canine impaction (85%) is reported to be more prevalent than labial impaction (15%).[1,2,9–12] Unilateral impaction is much more common than bilateral impaction.[11] McConnell et al[13] and Sambataro et al[2] have reported that 8% of canine impactions are bilateral. Kuftinec et al[7] reported that unilateral canine impactions are more common than bilateral ones by a factor of 5:1.

The definition of impaction varies among clinicians. Abron et al[12] defined impaction as a retardation or halt in eruption. Lindauer et al[14] defined a canine as being impacted if it was unerupted after complete root development or if the contralateral tooth was erupted for at least 6 months with complete root formation. Mason et al[15] defined an impacted tooth as one "whose eruption is considerably delayed, and for which there is clinical or radiographic evidence that further eruption may not take place." Kuftinec et al[7] defined impaction as a condition in which a tooth is embedded in the alveolus so that its eruption is prevented or the tooth is locked in position by bone or by the adjacent teeth.

Primary etiological causes of maxillary canine impaction include prolonged retention of the deciduous canine, trauma to other deciduous tooth buds, disturbances in tooth eruption sequence, lack of space, rotation of tooth buds, premature root closure, canine eruption into cleft areas, and localized pathological lesions such as dentigerous cysts and odontomas. Jacoby[16] discussed local factors such as arch length deficiency as an etiological factor in canine impaction. However, he reported that 85% of palatally impacted canines occur in patients with adequate arch length. McConnell et al[13] implicated a deficiency in maxillary width as a local mechanical cause of palatally displaced canines. The long developmental path of eruption of the maxillary canine also contributes to its potential for becoming impacted. Because the canines usually develop high in the maxilla and are among the last teeth to erupt, they must course a long distance before erupting into the dental arch. Thus, there is an increasing potential for mechanical disturbances leading to subsequent impaction. In fact, Coulter and Richardson[3] found that the maxillary canine traveled 22 mm during its course of eruption. Secondary etiological causes of maxillary canine impaction include febrile disease, endocrine disturbances, vitamin D deficiency, and abnormal muscle pressure.[5,12,16–18]

Genetic factors such as gender, race, supernumerary teeth, and small or congenitally missing lateral incisors may also play a role as an etiological factor in canine impaction. Gender may play a role because maxillary canine impactions occur twice as often in females than in males.[2,9,13,17] Maxillary canine impactions occur five times more often in Caucasians than in Asians.[12] The majority of canines are impacted palatally among Caucasians and buccally among Asians.[7] Peck et al[19] reported that 33% of patients with impacted canines have other congenitally missing teeth.

Early detection of impacted canines includes clinical examination of the permanent lateral incisors. Their abnormal position or angulation could indicate a deflected canine, which could potentially become impacted. Severely distally tipped crowns of lateral incisors might be pressured by the crown of a mesially displaced canine against the distal aspect of the lateral incisor root. A labially inclined lateral incisor could be the result of a displaced canine lying on the labial aspect of the lateral incisor root. Excessive or unusual mobility of the maxillary permanent lateral incisor could be the result of root resorption caused by a displaced canine. Shapira and Kuftinec[1] have reported a frequency of 12.5% for ectopically erupting maxillary canines causing some degree of incisor root resorption (significantly more so in girls than in boys).

One of the most frequently seen malocclusions in the primary and mixed-dentition stages is a transverse discrepancy between the maxillary and mandibular arches. According to Kutin and Hawes,[20] the prevalence of this malocclusion is 8%. Hanson et al[21] found the prevalence to be 12% in the primary dentition and 7.2% in the mixed dentition. A transverse discrepancy is not self-correcting, and many investigators recommend expansion of the maxillary arch during the mixed-dentition period.[22]

Thilander and Jakobsson[23] found that dental crowding usually displaced the canine in a labial direction but rarely caused an impaction. Jacoby[16] reported that 83% of arches with labial displacement of maxillary canines displayed dental arch space deficiency. He stated that dental crowding and arch length deficiency were not associated with palatally displaced canines. In contrast, McConnell et al[13] concluded that subjects with maxillary canine impactions had a transverse maxillary deficiency in the anterior portion of the dental arch. However, the examiners in the study did not identify the precise position of the unerupted maxillary canines, nor did they differentiate between labial and palatal impaction subjects. McConnell et al[13] also concluded that maxillary orthopedic expansion would be an interceptive modality in treating patients with palatally displaced canines. In contrast, Langberg and Peck[4] concluded that maxillary arch width is not a primary contributory factor in the genesis of the palatally displaced canine. They implicated programmed genetic mechanisms as the underlying cause of the palatally displaced canine. However, they selected their palatally displaced canine sample according to a "clear-cut" diagnosis of palatal ectopic displacement based on radiographs and clinical history.

Various radiographs have been used to diagnose impacted canines, including periapical, panoramic, occlusal, and cephalometric films. Two possible predictors of eventual treatment success for impacted canines are the mesiodistal location of the crown and the angulation of the tooth as measured on a panoramic radiograph.[6,11,14] Ericson and Kurol[10] found that the more mesially located the crown, the more reduced the likelihood of eruption after deciduous canine extraction. Power and Short[11] studied angulation as a prediction and found that if the tooth is angled more than 31° to the midline, its chance of eruption after deciduous extraction is decreased.

Lindauer et al[14] used the location of the cusp tip of the canine in question and its relationship to the adjacent lateral incisor to predict eventual impaction of the maxillary canine (Figure 1). He determined the probability for impaction according to the canine cusp tip location in one of four sectors. Sector I is the area distal to a line tangent to the distal heights of contour of the lateral incisor crown and root. Sector II is mesial to sector I but distal to a line bisecting the mesiodistal dimension of the lateral incisor along the long axis. Sector III is mesial to sector II but distal to a line tangent to the mesial heights of contour of the lateral incisor crown and root. Sector IV included all areas mesial to sector III. Lindauer et al[14] reported that up to 78% of the canines that had cusp tips located in sectors II through IV were destined to become impacted. Warford et al[9] found that sector location provides the greater influence on the prediction of impaction, with canine location in the more mesial sectors substantially predictive. Angulation did not provide any statistically significant additional predictability.

The objective of this study is to investigate whether maxillary arch width discrepancy is associated with the occurrence of potentially impacted canines. The sector classification of Lindauer et al[14] was used as an adjunct to localize the position of the impacted canines.

MATERIALS AND METHODS Return to TOC

In this study, both the experimental and control groups were randomly selected by using pretreatment records from the State University of New York at Stony Brook, School of Dental Medicine and from a local private orthodontic practice. The experimental group consisted of 84 orthodontic patients (42 male and 42 female subjects) in the mixed dentition with a maxillary transverse discrepancy. The control group in this study included 100 orthodontic patients (46 male and 54 female subjects) in the mixed dentition without a maxillary transverse discrepancy. In our study, we defined mixed dentition as a period in which the maxillary canines were unerupted and at least the primary second molars were retained.

Subjects were selected for the experimental group by visual observation of a clinically noticeable crossbite. The transverse discrepancy was calculated by using the difference between the maxillary and mandibular intermolar (IM) widths. IM width was measured with a bow divider and millimeter ruler. The maxillary IM width was measured as the distance between the mesial-lingual cusp tips of the right and left first molars. The mandibular IM width was measured as the distance between the central fossa of the right and left first molars. Two examiners independently evaluated panoramic radiographs and dental casts of randomly selected patients in the mixed dentition. Improper or distorted panoramic images were eliminated from the study. IM widths were measured and recorded. The maxillary lateral incisors and canines were traced from the panoramic radiograph of both groups, and the canine was placed into sector classification according to the study of Lindauer et al.[14] Canines found to be in sectors II, III, or IV were found to have increased potential for impaction.[14]

RESULTS Return to TOC

The mean age was 9.5 years for the experimental group and 9.9 years for the control group. The experimental group had a mean maxillary IM width of 36.3 mm and a mean mandibular IM width of 41.2 mm. The mean transverse discrepancy between the maxilla and mandible was 4.9 mm. Table 1 shows that 53.6% of subjects had an impacted canine in the experimental group, whereas only 19% had an impacted canine in the control group.

As seen in Table 2, having no canine impaction was the most common finding in both groups. However, there was a significantly smaller percentage of no canine impactions in the experimental group (46.4%) compared with the control group (81%). The percentage of unilateral impactions in the experimental group (42.9%) was similar to having no impaction (46.4%). The percentage of bilateral impactions in the experimental group was least with 10.7%. The percentage of unilateral and bilateral impactions in the control group was 14% and 5%, respectively. Of the total subjects in the experimental group with impacted canines (n = 45, 36 unilateral and 9 bilateral impacted canines), 80% were unilateral impactions (36 unilateral/ 45 total) and 20% were bilateral impactions (9 bilateral/45 total). Of the total subjects in the control group with impacted canines (n = 19, 14 unilateral and 5 bilateral), 74% were unilateral impactions (14 unilateral/19 total) and 26% were bilateral impactions (5 bilateral/19 total). Overall, for subjects with impacted canines from both groups (n = 64, 45 experimental and 19 control), 78% were unilateral impactions (50 unilateral/64 total) and 22% were bilateral impactions (14 bilateral/64 total).

Table 3 shows the percentage of sector combinations (right canine sector classification, left canine sector classification) for unilateral canine impactions of both groups. For the experimental group, 97.2% of the unilaterally impacted canines were in sector II and 2.8% were in sector IV. For the control group, 78.6% of the unilaterally impacted canines appeared in sector II and 21.4% appeared in sector III. Table 4 shows that 42.9% of subjects in the experimental group had a unilateral impacted canine, whereas only 14% had a unilateral impacted canine in the control group.

Table 5 shows the percentage of sector combinations for bilateral canine impactions for both groups. The number of subjects in both groups is quite low. As seen in this table, the sector combination “II, II” was most commonly seen in both the experimental group (66.7%) and the control group (60%). For the experimental group, the percentage was 22.2% for sector combination “III, II” and 11.1% for “IV, III.” No other sector combinations occurred in the experimental group. For the control group, percentage for sector combination “II, III” was 40%. No other sector combinations occurred in the control group. Table 6 shows that 10.7% of subjects in the experimental group had a bilateral impacted canine, whereas 5% had a bilateral impacted canine in the control group.

DISCUSSION Return to TOC

The present study investigates the correlation between maxillary transverse discrepancy and impacted canines in the mixed dentition. On the basis of the results of Warford et al,[9] we used sector rather than angulation as a predictor of canine impaction. Lindauer et al[14] found that 78% of impacted canines occur in sectors II, III, and IV. Warford et al[9] found similar results in that 82% of impacted canines were found in sectors II, III, and IV. On the basis of these studies, we classified an impacted canine as being in sectors II, III, or IV.

McConnell et al[13] determined that subjects with canine impaction demonstrate transverse maxillary deficiency in the anterior portion of the dental arch. In contrast, a study by Langberg and Peck[4] determined that maxillary transverse deficiency is not a primary contributory factor in the development of the palatally displaced canine. By using the chi-square test as seen in Table 1, we found that patients with a transverse discrepancy are more likely to have an impacted canine than those patients without a transverse discrepancy ($P < .0001$).

It has been reported that approximately 8% of all canine impactions are bilateral.[2,13] In our study, we found that 80% of canine impactions in the experimental group were unilateral and 20% were bilateral, as seen in Table 2. In the control group, 74% of canine impactions were unilateral and 26% were bilateral. Overall between the experimental and control groups, 78% of all canine impactions were unilateral and 22% were bilateral. This percentage is higher than that of the previously reported studies. For those subjects with unilateral impactions, the most common sector combinations were “I, II” or “II, I” for both the experimental and control groups, as seen in Table 3. For those subjects with bilateral impactions, the most common sector combination was “II, II” in both groups, as seen in Table 5. On the basis of our statistics as shown in Table 4, we concluded that patients with a transverse discrepancy are more likely to have a unilateral impaction compared with patients without a transverse discrepancy ($P < .0001$). However, we found that patients with a transverse discrepancy do not have a greater likelihood ($P > .05$) of having a bilateral impaction compared with patients without a transverse discrepancy, as seen in Table 6. This result may be attributed to the small sample size of patients with bilateral impaction.

Regardless of the etiology, maxillary canine impactions occur with enough frequency to warrant extensive study of preventive treatment modalities. According to previous research studies, the best time to begin assessing a patient for potential maxillary canine impaction is during the early mixed dentition, when the canine begins its intrabony movement into the dental arch. Currently, the most common preventive treatments for dealing with this problem are timely extraction of the deciduous canine and orthopedic expansion of the maxillary dental arch, both of which will help provide space for proper eruption of the permanent canine into the arch.

Ericson and Kurol[6] found that 78% of palatally displaced canines reverted to a normal eruptive pathway and assumed a clinically correct position after removal of the deciduous canine. Berger[24] proposed that removal of the deciduous canine together with widening of the arch in the premolar region should prevent incisor root resorption. McConnell et al[13] concluded that orthopedic expansion would be an appropriate interceptive procedure for treating palatally impacted canines. They concluded that orthopedic expansion of the maxillary arch may decrease the need for serial extraction techniques and extraction of primary canines to promote proper canine eruption. They also concluded that increasing arch width in transverse-deficient patients by expansion can minimize the need for premolar extraction and can also minimize lateral root resorption caused by eruption of the maxillary impacted canine. Possible sequelae of impacted canines include surgical exposure and orthodontic traction of the canine to guide it into the arch, extraction of the impacted canine, extraction of teeth adjacent to the impacted canine, increased treatment time and cost, increased risk of gingival recession and bone loss around the treated canine, and possible incisor root resorption.[25]

Based on this study, it is important to be aware of a potential maxillary canine impaction when a transverse discrepancy is clinically observed. If the canine is radiographically located in sector II, III, or IV according to the classification of Lindauer et al,[14] there is a high percentage that it will be impacted. Further studies may be considered to evaluate the treatment success of palatal expansion and deciduous canine extraction for prevention of potentially impacted canines. Maxillary occlusal radiographs would be a good supplementary film to help confirm results in future studies.

CONCLUSIONS Return to TOC

- Patients with a transverse discrepancy are more likely to have an impacted canine than are patients without a transverse discrepancy.
- Patients with a transverse discrepancy do not have a greater likelihood of having a bilateral impaction compared with patients without a transverse discrepancy. However, this may be due to the small sample size of patients with bilateral impaction.

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TABLES Return to TOC

Table 1. Overall—experimental vs control group

	Canine impaction	No canine impaction	Total
Experimental	45 (53.6%)	39 (46.4%)	84
Control	19 (19%)	81 (81%)	100
Total	64	120	184
Statistics	*df*	*P*-value	
Chi-square	1	<.0001	

Table 2. Type of impaction—experimental and control groups

Group	Impaction	Frequency	%
Experimental (n = 84)			
	None	39	46.4
	Unilateral	36	42.9
	Bilateral	9	10.7
	Total	84	100
Control (n = 100)			
	None	81	81
	Unilateral	14	14
	Bilateral	5	5
	Total	100	100

Table 3. Unilateral impaction—experimental and control groups

Group	Unilateral	Frequency	%
Experimental (n = 36)			
	I, II	16	44.4
	II, I	19	52.8
	I, III	0	0
	III, I	0	0
	I, IV	0	0
	IV, I	1	2.8
	Total	36	100
Control (n = 14)			
	I, II	6	42.9
	II, I	5	35.7
	I, III	1	7.1
	III, I	2	14.3
	I, IV	0	0
	IV, I	0	0
	Total	14	100

Table 4. Unilateral canine impaction

	Unilateral impaction	No unilateral impaction	Total
Experimental	36 (42.9%)	48 (57.1%)	84
Control	14 (14%)	86 (86%)	100
Total	50	134	184
Statistics	*df*	*P*-value	
Chi-square	1	<.0001	

Table 5. Bilateral impaction—experimental and control groups

Group	Bilateral	Frequency	%
Experimental (n = 9)			
	II, II	6	66.7
	II, III	0	0
			0
	II, IV	0	
	III, II	2	22.2
	III, III	0	0
	III, IV	0	0
	IV, II	0	0
	IV, III	1	11.1
	IV, IV	0	0
	Total	9	100
Control (n = 5)			
	II, II	3	60
	II, III	2	40
	II, IV	0	0
	III, II	0	0
	III, III	0	0
	III, IV	0	0
	IV, II	0	0
	IV, III	0	0
	IV, IV	0	0
	Total	5	100

Table 6. Bilateral canine impaction

	Bilateral impaction	No bilateral impaction	Total
Experimental	9 (10.7%)	75 (89.3%)	84
Control	5 (5%)	95 (95%)	100
Total	14	170	184
Statistics	*df*	*P*-value	
Chi-square	1	.1453	

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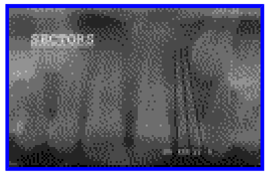

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Figure 1. The sector classification of Lindauer et al.[14] This figure illustrates a canine cusp tip located in sector I

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