Association of Maxillary Transverse Discrepancies and Impacted Maxillary Canines in Patients 10 – 25 Years Old

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Abstract

The aim of this study was to investigate the association between maxillary transverse discrepancy and the occurrence of impacted canines in patients 10-25 years old. Dental casts and panoramic radiographs were evaluated in 123 patients included criteria. The experimental group consisted of 61 patients with maxillary canine impactions. The control group included 62 patients without maxillary canine impactions. Study model analysis performed according to the Pont and Korkhaus method. Panoramic radiograph analysis performed according to Ericson and Kurol. The experimental group was then analyzed based on the position of canine impaction, labially or palatally impaction.

Results of this study showed that patients with a transverse discrepancy are potentially have an impacted canine. Anterior & posterior dental arch width and diagonal arch length in palatally impacted canine group were significantly greater than in the labially impacted canine (ANOVA test; p<0.05). The average angulation and distance of the canine tip to the occlusal were significantly different between the labially and palatally impacted canines groups (Independent t-test; p<0.05). There were an association between impacted canines and transverse discrepancies. Arch length discrepancy is thought to be a primary etiologic factor for labially impacted canines. If the maxillary canine radiographically located in sector > I, and grade > II there was a highly risk to impacted.

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Introduction

Today, cases of maxillary canine impaction increasingly encountered in the clinic. Patients often don't be aware because asymptomatic and often found incidentally when patients seeking orthodontic treatment. It is different from the third molar tooth impaction which often complaints of pain, headache, tinnitus, infection, trismus, sometimes even found a cyst or neoplasm.[1,2]

The maxillary canine is the second frequently impacted tooth in the dental arch after the third molar.[1–5] The incidence of maxillary canine impaction has been reported as involving approximately 1-3% of the populations[2,6]. Maxillary canines 10-20 times are more commonly impacted than mandibular canines, and is more common in women than men with a ratio of 1.5 – 2 : 1. Palatally canine impaction is reported to be more prevalent than labially canine impaction .[1-7] Unilateral impaction is much more common than bilateral impaction. Sambataro et al have reported that 8% of canine impactions are bilateral.[8]

The maxillary canines play a very important role in the appearance of the face, dental esthetics, growth arches, occlusion and mastication. It had a specific function as a corner stone, guidance occlusion, and was important in the process of mastication and mandibular excursive movements. Maxillary canines have reflexive and proprioceptive fibers and protect and stabilize the occlusion and because of its

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position, the tooth may also play a role in aesthetics and provide a harmonious arch between the anterior and posterior segments of the dental arch.[2] Therefore orthodontist will make every effort to maintain the existence of the tooth in the arch and make efforts to enable this tooth can be erupted into arches with good relationship.[2]

The aetiology of palatal canine impaction is not very clear. Some authors believe, contrary to labial impaction, that the presence of excess space in the upper arch could lead to palatal canine impaction by allowing the canine to cross back from the labial to the palatal side. Palatally and labially canine impactions are considered to be completely different entities. Labially canine impaction is thought to be a form of crowding. Insufficient space in the upper arch for the eruption of the maxillary canine culminates in its impaction. Nevertheless, given time and space this tooth will usually erupt in the oral cavity.[9] Local factors such as arch length deficiency as an etiological factor in canine impaction.[9-11] However, Langberg et al. reported that 85% of palatally impacted canines occur in patients with adequate arch length.[9] 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.[11] Thus, there is an increasing potential for mechanical disturbances leading to subsequent impaction.[11]

Materials and methods

A total of 123 subjects who came to the clinic of Dental Hospital Faculty of Dentistry Universitas Indonesia during the period of July 2015 - March 2016. The inclusion criteria for enrollment of subjects were as follows: (1) Patients who come to the clinic Orthodontics or Pedodontics for orthodontic treatment (2). Male / female, 10-25 years old. (3) Absence of previous orthodontic treatment. (4) There is no systemic disorders and hereditary disorder. (5) Absence of supernumerary teeth, odontomas, cysts, craniofacial malformations, or sequelae of traumatic injuries in maxilla. (6) No maxillary canine impaction for subject as control.

The subjects were allocated to three groups: group I (patients with palatally impacted canines), group II (patients with labially impacted canines) and group III (patients with no maxillary canine impaction as controls). Ethical approval was obtained for the enrollment of the subjects in the clinical trial. Informed consent was also signed by the parents of all subjects or by the patients enrolled in the trial.

Dental casts and panoramic radiographs were evaluated in 123 patients included criteria. The experimental group consisted of 61 patients with maxillary canine impactions. The control group included 62 patients without maxillary canine impactions. Study model analysis performed according to the Pont method by using digital caliper (mm) on the upper arch by measuring (a) the width of anterior dental arch that is the distance of inter-premolar. The inter-premolar width was measured by placing the digital caliper tips into the deepest portion of the central fossae of the upper first premolars at their junctions with the most lingual aspect of the buccal cusp (b) the width of posterior dental arch is the distance of inter-molar of the upper arch. The inter-molar width was recorded with the digital caliper tips placed into the deepest portion of the central fossae at its junction with the most lingual aspect of the mesio buccal cusp. (c) the distance of diagonal dental arch was measured by placing the digital caliper tipsfrom the cusp tip of first premolar to the mesial incisal edge of first incisor (Figure 1.1) and (d) the length of the perimeter of the dental arch according Korkhaus method that is the distance from the mesial side right first molars to the left first molar were measured by using of brass wire (Figure 1.2)[12,13]. All dental cast measurements were made at three times by the same examiner (KA) using a digital caliper 150mm x 6" / 0.01mm precision (Krisbow KW06-351). The mean of the three closest measurements was used in the calculations. The measurement error was calculated according to Dahlberg's double determination method. The results of the measurement error were 0.55 mm for arch perimeter, 0.24 mm diagonal width and 0.30 and 0.34 mm for inter-premolar and inter-molar arch widths, respectively.

In panoramic radiograph, the angulation of the long axis of the maxillary canine tooth, the tooth spacing of the maxillary canines to the occlusal plane as well as the location of the maxillary canines by sector and grade classification of permanent maxillary canines of experimental groups were traced and measured according to Ericson and Kurol[14,15]. To evaluating the position of the canine was confirmed by means of Clark's tube shift rule using intraoral radiographs of the canine region. The following measurements:

(1) α angle: mesial inclination of the crown of the permanent maxillary canine to the midline.[14,15]

(2) *d* distance: distance of the cusp tip of the permanent canine from the occlusal line.[14,15]

(3) *sector*: indicating the canine cusp tip position of the crown of the maxillary canine impaction with respect to the central and lateral incisors (5 sectors). Sector 1 is the area distal to a line tangent to the distal heights of contour of the lateral incisor crown and root. Sector 2 is mesial to sector 1 but distal to a line bisecting the mesiodistal dimension of the lateral incisor along the long axis. Sector 3 is mesial to sector 2 but distal to a line tangent to the mesial heights of contour of the lateral incisor crown and root. Sector 4 is distal to a line bisecting the mesio distal dimension of the central incisor along the long axis and sector 5 is correspondence with the mesial half of the upper central incisor.[14,15]

(4) *Grade* : indicating the maxillary canine root position with respect to the first and second premolars (3 grades). Grade I if the position of the root permanent maxillary canine impaction was placed below the apex of primary canine. Grade II if the position of the root permanent maxillary canine impaction was placed below the apex of first premolar. Grade III if the position of the root permanent maxillary canine impaction was placed below the apex of second premolar.[14,15]

The magnification factor for the panoramic films was 18 per cent. All measurements were performed, with the same investigator. The estimate of the power of the study was performed before the beginning of the clinical part of the trial. Taking into consideration the standard deviations of the diagnostic measures on the panoramic radiographs and the use of parametric or categorical statistics, the calculated power of the study exceeded 0.90 at an alpha = 0.05.Accuracy of measurements on panoramic radiographs was calculated using the Dahlberg's formula on measures repeated on 15 subjects selected randomly from the experimental group. The method error was 0.9 degrees for α angle, 0.4 mm for the *d* distance. The appraisal of the sector and grade of maxillary canines impaction showed a reproducibility of 100 per cent.

Statistical Analyses

Means and standard deviations for the two groups were calculated for all variables using SPSS Statistic 17.0 (Chicago, Illinois, USA). The differences between anterior and posterior of dental arch widths, perimeter and diagonal arch length the impaction and non impaction groups were determined using a Student's *t*-test and ANOVA; *P*<0.05 were considered significant. The prevalence rates for sectors and grade of canine impaction in experimental groups were compared by means of chi-squared tests (*P*<0.05).

Results

The mean age was 15.9 ± 5.1 years for the experimental group and 18.8 ± 5.1 years for the control group. The experimental group had 34.1 % male and 65.9 % female. Table 1 shows that 28.5% of subjects had palatally impacted canine and 21.1 % had labially impacted canine in the experimental group. There were statistically significant differences among the three groups p<0.05.

Cases	N	Percent	Cumulative Percent	P
				0.002*
Palatally Impaction	35	28.5	28.5	
Labially Impaction	26	21.1	49.6	
Non Impaction	62	50.4	100.0	
Total	123	100.0		
Pearson Chi-Square test; p<0.05 (Sig. 2-Tailed)* = Significant				

Table 1. Frequency and Distribution of Patients.

The descriptive statistics for the measurements on dental casts based on gender in experimental groups is reported in table 2. Mean value of anterior dental arch widths and perimeter dental arch length in male (36.48 mm ± 3.79 mm) and (79.62 mm ±5.85 mm) revealed that wider than female (34.46 mm ± 3.13 mm) and (75.48 mm ± 5.89 mm) and there were statistically significant difference (Independent t-test; p<0.05). Although the mean value of posterior dental arch widths and diagonal dental arch length is greater in male than female, but there were no statistically significant.

Table 3 showed that mean value of anterior and posterior dental arch widths, perimeter dental arch length and diagonal length among the two groups ie patients with maxillary canine impaction and non impaction were statistically significant (independent t-test; p<0.05). Results of this study showed that patients with a maxillary transverse discrepancy are more likely to have an impacted canine than those patients without a maxillary transverse discrepancy.

	N	Mean ± SD (mm)	95% CI (mm)	P
Anterior of Dental Arch Widths				0.027*
Male	24	36.48 ± 3.79	34.88 - 38.08	
Female	37	34.46 ± 3.13	33.42 - 35.50	
Posterior of Dental Arch Widths				0.102
Male	24	47.43 ± 3.54	45.93 - 48.92	
Female	37	45.67 ± 4.30	44.24 - 47.11	
Perimeter of Dental Arch Lengths				0.009*
Male	24	79.62 ± 5.85	77.15 - 82.09	
Female	37	75.48 ± 5.89	73.52 - 77.44	
Diagonal of Dental Arch Lengths				0.091
Male	24	26.62 ± 2.74	25.47 - 27.78	
Female	37	25.34 ± 2.90	24.38 - 26.31	

Table 2. Comparisons of the Anterior and Posterior Dental Arch width, the Diagonal Arch length and Perimeter of Dental Arch Length of Maxillary Canine Impactions.
Independent t-test ; p<0,05 (Sig 2- Tailed); * = Significant.

	N	Mean ± SD (mm)	95% CI (mm)	P
Anterior of Dental Arch Widths				0.000*
C Impaction	61	35.07 ± 3.29	26.39 - 44.40	
Non Impaction	62	37.39 ± 2.30	33.56 - 45.19	
Posterior of Dental Arch Widths				0.005*
C Impaction	61	46.63 ± 3.33	36.08 - 54.42	
Non Impaction	62	48.28 ± 3.11	42.58 - 56.07	
Perimeter of Dental Arch Lengths				0.015*
C Impaction	61	77.11 ± 6.17	60.00 - 91.33	
Non Impaction	62	79.71 ± 5.47	67.33 - 96.33	
Diagonal of Dental Arch Lengths				0.006*
C Impaction	61	25.85 ± 2.89	18.84 - 31.70	
Non Impaction	62	27.04 ± 1.69	23.85 - 33.70	

Table 3. Comparisons of Mean value, Deviation Standard and Confidence Level of the Maxillary Canine Impaction and Non Impaction.
Independent t-test; p<0,05 (Sig 2- Tailed); * = Significant.

Table 4. Showed that analysis of variance [ANOVA], (*P* <0.05) of anterior maxillary dental arch width (inter-premolar), posterior dental arch width (inter-molar) and diagonal arch length in labially impacted canine group were significantly smaller than in the palatally impacted canine and control groups. However, the perimeter of dental arch length between groups no significantly difference.

	N	Mean ± SD (mm)	95% CI (mm)	P
Anterior of Dental Arch Widths				0.000*
Palatally Impactions	35	35.60 ± 2.78	34.64 - 36.56	
Labially Impactions	26	35.17 ± 3.34	33.82 - 36.52	
Non Impactions	62	37.39 ± 2.30	36.80 - 37.97	
Posterior of Dental Arch Widths				0.050*
Palatally Impactions	35	47.06 ± 3.03	46.02 - 48.10	
Labially Impactions	26	46.73 ± 3.19	45.44 – 48.15	
Non Impactions	62	48.28 ± 3.11	47.49 – 49.07	
Perimeter of Dental Arch Lengths				0.104
Palatally Impactions	35	77.49 ± 4.94	75.79 - 79.18	
Labially Impactions	26	77.56 ± 6.90	74.77 - 80.35	
Non Impactions	62	79.71 ± 6.90	78.32 - 81.10	
Diagonal of Dental Arch Lengths				0.006*
Palatally Impactions	35	25.43 ± 2.75	24.48 - 26.37	
Labially Impactions	26	26.42 ± 3.02	25.20 - 27.64	
Non Impactions	62	27.04 ± 1.69	26.61 - 27.46	

Table 4. Comparisons of Mean value, Deviation Standard & Confidence Level of Palatally, labially Maxillary Canine Impactions and Non Impaction.
Anova; p<0,05 (Sig 2- Tailed); * = Significant.

	N	Mean ± SD	95% CI	P
Angulation of Canine (°)				0.000*
Palatally Impactions	35	30.49 ± 6.92	24.67 - 36.30	
Labially Impactions	26	13.12 ± 8.30	5.72 - 20.51	
Distance C to Occlusal (cm)				0.001*
Palatally Impactions	35	1.34 ± 0.54	1.16 - 1.53	
Labially Impactions	26	0.78 ± 0.77	0.47 - 1.09	

Table 5. Comparisonsof Angulation and Distance to Occlusal of Palatally and labially Maxillary Canine Impactions.
Independent t-test; p<0,05 (Sig 2- Tailed); * = Significant.

The average angulation of canine and distance of the canine tip to the occlusal in table 5 showed were significantly different between the labially impacted canines and the palatally impacted canines groups (Independent t-test; p<0.05). It was distal and mesial to the lateral incisor long axis, respectively. The inclination angle related to the medial plane in the palatally impacted was30.49° ± 6.92° otherwise, in labially impacted was 13.12° ± 8.3°.

Position of Canine (Sectors)	Palatally Impaction N	Frequency	Labially Impaction N	Frequency	P
					0.000*
1	3	8.5 %	21	80.8 %	
2	13	37.2 %	4	15.4 %	
3	14	40.0 %	0	0.0 %	
4	4	11.5 %	1	3.8 %	
5	1	2.8 %	0	0.0 %	
Total	35	100.0 %	26	100.0%	
Position of the Root of Canine (Grade)	N	Frequency	N	Frequency	P
					0.009*
I	10	28.6 %	20	77.0 %	
II	15	42.9 %	4	15.3 %	
III	10	28.5 %	2	7.7 %	
IV	0	0.0 %	0	0.0 %	
Total	35	100.0 %	26	100.0 %	

Tabel 6. Comparison of Canine Impactions by Sectors and Grades Classification.
Pearson Chi-Square Test; p<0.05 (Sig. 2-Tailed, * = Significant.

The Mean value of distance canine impaction to occlusal 1.34 cm ± 0.54 cm (palatally) and 0.78 cm ± 0.77 cm (labially) and significantly difference (independent t-test; p <0.05).

Comparisons of canine impaction by sectors and grades classification in table 6 showed that palatally maxillary canine tips impaction mostly in sectors 2 & 3 (37.2% and 40.0 %) and labially impaction mostly in sector 1 (80.8 %), as well as grade classification, the position of root maxillary canine impaction mostly in grade II & III in palatally impaction and grade I in labially impaction, and significantly difference (Pearson Chi-Square; p<0.05 (Sig.2- Tailed).

Discussion

The experimental group from the result had 34.1% male and 65.9% female. (M:F= 1 : 1.9). This is in accordance with the results of previous studies which stated that canine impactions are more frequent among females than males (F : M = 1.5 - 2.3 : 1)[1-5]

Table 1 showed that subjects in the experimental group had palatally impacted canine (28.5%) greater than labially impacted canine (21.1%). It was previously mentioned, 85% of impactions are palatally impactions compared to15% that are labially impactions[1-3,6,7]. The result of this research, the difference of palatally canine impaction cases is not as big as previously studies, but there were statistically significant differences among the three groups (Pearson Chi-Square; p<0.05). This may be due patients came to our clinic especially in orthodontic clinic because canine ectopic that effect esthetics problem. It is difference from palatally canine impaction that asymptomatic and often found incidentally when patients make panoramic radiograph.

Mean difference between impaction and non impaction in male and female subjects in table 2 revealed that there were significantly difference transverse discrepancy between male and female. This is in accordance with the previous studies conducted by Forster CM et al., 2008 demonstrated that males and females exhibit different skeletal facial dimensions[16]and studies conducted by Khera et al., 2012 suggested that maxillary intercanine width, first interpremolar width and first intermolar width were greater in males as compared with females[17]. A result from this research, we found that transverse maxillary deficiency not only in anterior portion of dental arch, but also in posterior portion of dental arch, as seen in table 3. This shows that patients with a transverse discrepancy are more likely to have an impacted canine than those patients without a transverse discrepancy (*P*< .0005).

By using the ANOVA test (*P* <0.05) as seen in table 4, we found that anterior maxillary dental arch width (inter-premolar), posterior dental arch width (inter-molar) and diagonal arch length in palatally impacted canine group were significantly greater than in the labially impacted canine. This is in accordance with the previous studies conducted by Langberg and Peck[9] determined that maxillary transverse deficiency is not a primary contributory factor in the development of the palatally displaced canine. They reported that 85% of palatally impacted canines occur in patients with adequate arch length. However, Schindel et al. found that maxillary transverse discrepancies potentially impacted maxillary canines in mixed-dentition patients.[10] Richardson found that palatally impacted canines actually failed to initially cross from the palatal to the buccal side but continued to descend on a palatal pathway throughout their development.[5]

Comparisons of angulation and distance of the canine tip to the occlusal in table 5. showed that palatally impacted had inclination angle greater than labially impacted and statistically significantly different (Independent t-test; p<0.05). This means that palatally canine impactions were more difficult to eruption than labially impacted. Ericson and Kurol had evaluation, if the tip of the maxillary canine impaction does not go past more than half of the root of the lateral incisor and the inclination angle related to the medial plane is not greater than 55° the average success rate (normal eruption) is about 80% and they found that 78% of palatally impacted canines reverted to a normal eruptive pathway and assumed a clinically correct position after removal of the deciduous canine.[15,18- 22]

By Using Pearson Chi-Square, in table 6 showed that the most common sector of palatally maxillary canine impaction in sectors 2 & 3 (37.2% and 40.0 %) and labially impaction mostly in sector 1 (80.8 %), and statistically significant difference (p<0.05).As well as grade classification, the position of root maxillary canine impaction mostly in grade II & III in palatally impaction and grade I in labially impaction, and significantly difference (Pearson Chi-Square; p<0.05. Sig.2- Tailed).

Based on this study, it is important to be aware if the canine is radiographically located in sector II, III or more according to the classification of Ericson and Kurol, and position of the root maxillary canine impaction in grade > II there is a high percentage that it will be impacted.[15,18-22]

Conclusions

Results of this study showed that patients with a maxillary transverse discrepancy are more potential for the occurrence of canine impaction than those patients without a maxillary transverse discrepancy and there were significantly difference transverse discrepancy between male and female.

Maxillary transverse deficiency is not a primary contributory factor in the development of the palatally impacted canine.

If the maxillary canine radiographically located in sector > I, the position of the root maxillary canine in grade > II there was a highly risk to impacted.

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Declaration of Interest

The authors report no conflict of interest.

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