International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Evaluation and Comparison of Arch Dimensions in Patients Presenting with and Without Maxillary Canine Impaction in Davangere Population

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ABSTRACT

OBJECTIVE: To evaluate and compare the arch dimensions in patients presenting with and without canine impaction, in Davangere population.

METHOD: 120 subjects were divided into three groups of 30 each. Group 1- subjects with palatally impacted canine, Group 2- subjects with buccally impacted canine and control group. Model analysis was done for each patient. Arch dimensions such as intercanine width, interpremolar width, intermolar width, arch length and palatal height index was evaluated using a Korkhaus divider.

RESULT: Palatally impacted canine group showed statistically significant increase in inter canine width when compared to control. Buccally impacted canine showed a statistically significant reduction in inter-canine width values when compared to Palatally impacted canine.

Buccally impacted canine had a statistically significant reduction in inter-premolar width values when compared to Controls. Buccally impacted canine showed statistically significant decrease in interpremolar width when compared to Palatally impacted canine.

CONCLUSION: There exists an association between arch dimensions and canine impaction. The cases with buccal canine impaction exhibit a reduced intercanine and interpremolar width and the cases with palatal canine impaction present with mild increase in intercanine width and interpremolar width but the variation in arch dimension is not as strongly associated as buccal canine impaction cases.

KEYWORDS: Maxillary canine impaction, Arch Dimensions, Davangere population

1. INTRODUCTION

Tooth eruption is defined as the axial movement of a tooth from its developmental site within the alveolar bone to its functional position in the dental arch.[1] It is a localized, bilateral, symmetric, and precisely timed developmental process.[2] Abnormal eruption can be caused by a lack of functionality of the tissue layers

that are important for the eruption process. One of the common presentations of abnormal eruption is arrested eruption. According to the stage in which it appears; arrested eruption presents either as impaction, primary retention or second retention. [3]

Impaction is defined as the cessation of eruption of a tooth due to a clinically or radiographically detectable physical barrier in the eruption path, or due to abnormal positioning of the tooth, and for which there is clinical and radiographic evidence that further eruption may not occur within the normal period of growth.[4] Impaction should be considered when there is an un-erupted tooth after complete root development, or when the contralateral tooth has been erupted for at least 6 months with complete root formation. [5] Impactions are a common problem in dentistry, often requiring surgery and long-term orthodontic treatment. The permanent maxillary canine is the second most frequently impacted tooth after the third molar.[6]

The process of eruption of the permanent canines leading to their final positioning in the oral cavity is complex and the longest of all the permanent teeth. The canine moves a distance of around 22 mm between the ages of 5 and 15 years.[7] If the tooth does not follow the proper trajectory of eruption, the canine tends to become impacted.

The etiology of impacted canines is obscure and most probably multifactorial. One of the factors in the etiology of canine impaction is the availability of space in the arch. It has been proposed that buccal and palatal impacted canines are two different entities characterised by different etiopathogeneses. To put it briefly, according to guidance theory hypoplastic or missing lateral incisor is associated with palatally impacted canine[8] and according to the genetic theory, aplasia of premolars and third molars and the presence of supernumerary teeth are also seen.[9] These theories are substantiated by the fact that most palatally impacted canine cases are not associated with space deficiency, except in a study conducted by McConnell et al.[10] In contrast, buccally impacted canines are commonly thought to be associated with dental arch and skeletal (premaxilla) deficiencies[11], although recently it was reported that buccally impacted canines were also present in a small but significant number of patients without crowded anterior teeth.[12]

Maxillary canine impactions also show an ethnic variability. Most impacted canines are palatally displaced in American and European ethnic group patients [10] but buccally displaced in Asian ethnic group patients.[8] As there is a difference in predilection for palatally and buccally impacted canines between American, European and Asian ethnic groups, it is necessary to ascertain whether the theories and factors established for American and European patients can be extrapolated to the Asian scenario. Hence, the primary objective of this study is to evaluate and compare the arch dimensions in patients presenting with and without canine impaction, in Davangere population, so that the identification of the causative factor can be established in the preliminary stages of orthodontic diagnosis and treatment planning, which will better equip the clinician to prepare and deliver timely and comprehensive oral health care.

2. METHODOLOGY

The data was obtained from the pre-treatment records of the patients, from the file section of Department of Orthodontics and Dentofacial Orthopaedics, Bapuji Dental College and Hospital, Davangere.

Sample size was calculated using following formula

$$n = \left(\sigma \frac{z_{1-\alpha/2} + z_{1-\beta}}{\mu_A - \mu_B}\right)$$

Where:

- n sample size
- σ is standard deviation = 2.0
- α is Type I error = 5%
- β is Type II error, meaning 1−β is power = 80%
- μ is expected mean (μ_A = 30.25 and μ_B = 30.12)

Calculated sample size is 30 in each group and 60 in control.[13,14]

Cases with unilateral or bilateral, buccal or palatal, maxillary canine impaction between the age of 14 and 35 years were selected.

The Study subjects was divided into the following groups.

Group 1: PALATALLY IMPACTED CANINE: Patients with impacted canine on the palatal surface of the maxilla

Group 2: BUCALLY IMPACTED CANINE: Patients with impacted canine on the labial or buccal surface of the maxilla

Group 3: CONTROLS: Patients presenting without canine impaction. The subjects will be matched according to:

1. Age
2. Gender
3. Type of malocclusion

b. Analysis of patient pre-treatment models:

Patients' pre-treatment records will be obtained and, on the pre-treatment, study model (Figure 1) the following measurements will be taken.

Palatal depth and **arch length (AL)** will be measured using a three-dimensional bow divider (Korkhaus Divider) (Figure 2,3) at the level of the occlusal plane of the maxillary first molars. The three-dimensional divider has a horizontal and a scaled vertical axis. The horizontal axis indicates arch length measured from the labial surfaces of the upper central incisors to the first molars, when the divider tips were placed in the molar fossae. Palatal depth is measured on the vertical axis.[13]

Intermolar width (IMW) will be recorded using the Korkhaus divider on the horizontal scale. Measurement will be taken from the point of intersection of the transverse fissure with the buccal fissure of the maxillary first permanent molars.

The **Palatal Height Index (PHI)** will be subsequently calculated by dividing palatal height by the intermolar width using the following formula: [13]

Palatal depth x100 = **PHI**

Intermolar width

Interpremolar width (IPW) will be recorded using the Korkhaus divider on the horizontal scale. Measurements will be taken from the lower-most point of the transverse fissure of the maxillary first premolars.[13]

Intercanine distance (ICW) will be measured by placing the Korkhaus divider tips on the cingulum of the deciduous canines or on the midpoint of the alveolar crests in the impaction group. This measurement will be recorded in the control group from the cingulum of the canines.[13]

All the data was tabulated using Microsoft Excel software and subsequently sent for statistical analysis.

3. RESULT

DEMOGRAPHIC DETAILS OF THE STUDY SAMPLE

The retrospective sample of cases consisted of more female patients (66.7%) than male patients. This finding is quite similar to most of the global studies in this context. The age range of the cases were 14 to 22 years for the palatably impacted canine group (Mean 17.37; SD 2.526), 14 to 21 years for the ducally impacted canine group (Mean 16.93; SD 2.258) and for the control group it was 14 to 22 years (Mean 17.15; SD:2.385).

No statistically significant difference in age was found between the groups (p=0.0782).

The sample characteristic with regard to the cases and controls are given in the table (Table 1)

ARCH DIMENSION COMPARISONS BETWEEN GROUPS:

For intergroup comparison of the Arch Dimension among the groups, ANOVA test was done. The output of the ANOVA analysis and whether there is a statistically significant difference between our group means is summarized below (Table 2).

Intercanine Width

The intercanine width is statistically significant between the groups with a mean square of 42.037 and a p value of 0.002.

Interpremolar Width

The interpremolar width is highly significant, statistically, between the groups with a mean square of 31.546 and a p value of 0.001.

Intermolar Width

The intermolar width is not statistically significant with a mean square of 9.737 and a p value of .122.

Arch Length

The arch length is not statistically significant with mean square of 5.136 and a p value of .376.

Palatal Height Index

The palatal height index is not statistically significant with a mean square of 3.999 and a p value of .859.

The ANOVA analysis helps us evaluate which parameter is statistically significant but does not indicate specifically which groups showed the significant value. To confirm the exact groups, Tukey's HSD (honestly significant difference) test was conducted.

Tukey's HSD (honestly significant difference) test was done to evaluate the specific differences between groups and the results revealed (Table 3)

INTERCANINE WIDTH: The comparison of intercanine width between groups, revealed that Group 1(Palatally impacted canine) showed a statistically significant increase in intercanine width when compared to Group 3(P) (Mean Difference: 1.617; Std.Error: .562; p= .013).

Group 2 (Buccally impacted canine) showed a statistically significant reduction in inter-canine width values when compared to Group 1(Palatally impacted canine) (Mean Difference: -2.267; Std.Error: 0.649; p= 0.002).

INTER-PREMOLAR WIDTH: The comparison of inter-premolar width between groups, revealed that Group 2(Buccally impacted canine) had a statistically significant reduction in inter-premolar width values when compared to group 3(Controls) (Mean Difference: -1.5667; Std.Error: .4505; p=0.002)

Group 2(Buccally impacted canine) showed statistically significant decrease in interpremolar width when compared to Group 1(Palatally impacted canine) (Mean Difference: -1.8333; Std.Error: 0.5202; p= 0.002).

4. DISCUSSION

The buccal or palatal position of impacted maxillary canine and the existing arch dimensions seem to have an evident association which has been investigated extensively in the past. Literature illustrates that palatally displaced maxillary canines occur more commonly in patients where the arch width is in excess and buccal impaction occurs more frequently in cases where crowding is seen or arch dimensions is reduced. Thus, if we can evaluate and obtain the data to corroborate such findings then we can endeavour to prevent the canine from getting impacted due to space conditions in the arch.

These studies are in agreement with the present study where the palatal impacted canine group is showing a significant increase in intercanine and interpremolar width and few samples also showed the presence of peg shaped lateral incisors or missing lateral incisors.

The reason discussed in the literature about this association is that the excessive space in the maxilla could be a contributory factor in the palatal displacement, for it enables sufficient space for the canine tooth bud to move and deviate from its original position, which is labial in arch, and migrate across the arch to the palatal area. Also, the absence of guidance from the lateral incisor, allows this new course to be established. Another reason is the possible biological relation between impacted canine and tooth size reduction. The theory is that anomalies of number, tooth size reduction and impacted canine are three of the covariant in a genetically controlled complex dental disorders occurring frequently combined instead of an anomalous lateral incisor having a mechanical effect over the canine position. It is possible that the gene or genes responsible for the control of the eruption and consequently for the palatal displaced canines are connected to the gene or genes causative of hypodontia/incisor agenesis. The presence of teeth smaller than the average in the sample with retained canines support previous reports that palatal canine impaction is developed in patients with appropriate dento-alveolar arch space.[15]

The only contradictory study conducted in this regard is a study conducted by McConnel and colleagues (1996), which reported that subjects with impacted maxillary canines had transverse deficiencies in the anterior portion of the maxillary arch. It was stated that mean intercanine width for the experimental group was 2 standard deviations below that of the control group. It was also reported that approximately 71% of the patients had palatally displaced canines and 29% had labially displaced canines. However, no differentiation of arch dimensions, between palatal and labial impaction was noted in their results. In addition, the age of the participants was not revealed, and the control group was not adequately defined or matched. A shortcoming of this study was the fact that the measurement points were based on a visual estimate of the putative ‘normal’ site of canine eruption. Accordingly, this technique was considered ‘an unreliable estimate and contraindicated for a quantitative study.[16]

As mentioned earlier, literature demonstrates that the buccal or palatal impaction of a maxillary canine shows ethnical variability and this ethnical variability may be attributed to various factors such as genetics, tooth morphology and arch dimensions. Since canine impaction is multifactorial in its etiology and also presents with an ethnical variability it is important to verify whether the predisposing factors which contribute to the impaction of the canine in other populations are applicable to our Indian population as well. So, in the present study the sample population chosen was from Davangere in Karnataka. This is to be considered a pilot study in terms of the entire population of the Indian sub-continent. Many such studies have to be conducted to be able to provide adequate data to cross reference with the studies conducted in various population groups across Europe, America and Asia.

In the present study few samples who presented with peg shaped or microdont lateral incisors also presented with maxillary canine impaction. This is in conjunction with the Guidance Theory of canine

impaction as stated by Miller that the root of the maxillary lateral incisor guides the erupting maxillary canine into its correct position in the oral cavity.Thus with small or absent lateral incisors the incidence of maxillary canine impaction increases three times (Becker), with peg shaped lateral incisors also the incidence increases (Brin et al 1986) also a higher incidence is associated with class II div 2 malocclusion where the lateral incisor roots are torque labially (Moosy 1994).

As established in previous studies, the present study also demonstrated that the incidence of buccal canine impaction is more in cases where the arch dimensions are reduced and palatal canine impaction are more in cases where excessive space is there in the arch. The intercanine width and interpremolar width showed a significance value of 0.002 and 0.001 respectively (i.e., $p = 0.002$), which is below 0.05. and, therefore, there is a statistically significant difference in the variation in intercanine width and interpremolar with when compared to the presence of canine impaction.

Canine impaction though a common clinical challenge has been more explored in aspects of diagnosis and treatment planning than in aspects of prevention. If the clinician can identify the factors that lead to the impaction of the maxillary canine and intervene at the right time then we can prevent its impaction and thereby saving us from the long and ardous process of disimpacting it. As has been said throughout the ages *"Prevention is better than cure."*

STRENGTHS OF THE STUDY

1. The strengths of this study lie in that selection bias was avoided by adequate matching of the cases and controls using gender, age and type of malocclusion.
2. Also confounding factors such as severe crowding, malformed arches, presence of syndromes or trauma which could have led to the impaction of the canine were not included.

LIMITATIONS OF THE STUDY:

1. In order to establish a strong positive correlation between arch dimension and its ability to predict whether a maxillary canine will get impacted, a longitudinal prospective study design may be employed wherein the same study subjects are observed until the maxillary canine is fully erupted or the chronological age of eruption is crossed. At that point of time, they must be evaluated to see if the prediction made was accurate or not. However, ethical issues may arise here, since if the prediction is accurate and an unfavourable path of eruption has been fully established, treatment of such subjects should be prompt.
2. A larger sample size could allow the use of more correlational statistical analyses to ensure the result is not occurring by chance.

5. CONCLUSION

Maxillary canines are the teeth most likely to be impacted, after the third molars. The reported prevalence of impaction varies between 0.8% and 23.5%. The maxillary canine follows a long and tortuous path of eruption and the predisposing factors to its impaction are varied. They range from the presence of an abnormal or pathological condition such as: neoplasm, cyst, dilacerated root, ankylosis, iatrogenic or systemic conditions. If the clinician can identify the factors that lead to the impaction of the maxillary canine and intervene at the right time then we can prevent the maxillary canine from getting impacted and thereby save us from the long and arduous process of disimpacting it.

From the present retrospective case-control study the following conclusions can be drawn:

1. There exists an association between arch dimensions and canine impaction.
2. The cases with buccal canine impaction exhibit a reduced intercanine and interpremolar width
3. The cases with palatal canine impaction present with mild increase in intercanine width and interpremolar width but the variation in arch dimension is not as strongly associated as buccal canine impaction cases.

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TABLES

Table 1: Descriptive data of age across groups

TABLE									
	GROUP 1			GROUP 2			GROUP 3		
	N	Mean	S D	N	Mean	S D	N	Mean	S D
AGE	30	17.37	2.526	30	16.93	2.258	60	17.15	2.385

Table 2: ANOVA analysis of arch dimensions

TABLE 2						
		Sum of Squares	df	Mean Square	F	Sig.
Intercanine Width	Between Groups	84.075	2	42.037	6.647	.002
Interpremolar Width	Between Groups	63.092	2	31.546	7.770	.001
Intermolar Width	Between Groups	19.475	2	9.737	2.139	.122
Intermolar Width	Between Groups	19.475	2	9.737	2.139	.122
Palatal Height Index	Between Groups	7.998	2	3.999	.153	.859

Table 3: Tukey Post Hoc Analysis of arch dimensions

TABLE 3							
						95% Confidence Interval	
Dependent Variable	(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Inter-canine Width	1	2	2.267*	.649	.002	-3.81	-.73
		3	-1.617*	.562	.013	-2.95	-.28
	2	1	-2.267*	.649	.002	.73	3.81
		3	.650	.562	.482	-.68	1.98
	3	1	1.617*	.562	.013	.28	2.95
		2	-.650	.562	.482	-1.98	.68
Interpremolar Width	1	2	-1.8333*	.5202	.002	-3.068	-.598
		3	-.2667	.4505	.825	-1.336	.803
	2	1	1.8333*	.5202	.002	.598	3.068
		3	1.5667*	.4505	.002	.497	2.636

	3	1	.2667	.4505	.825	-.803	1.336
		2	-1.5667*	.4505	.002	-2.636	-.497

FIGURES

Figure 1: Pre-Treatment Study Model

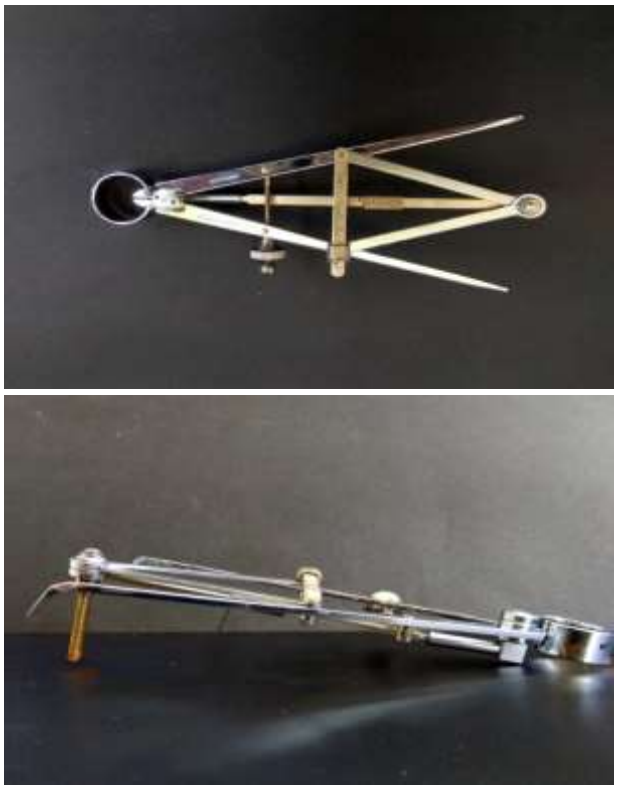

Figure 2: Korkhaus Bow Divider

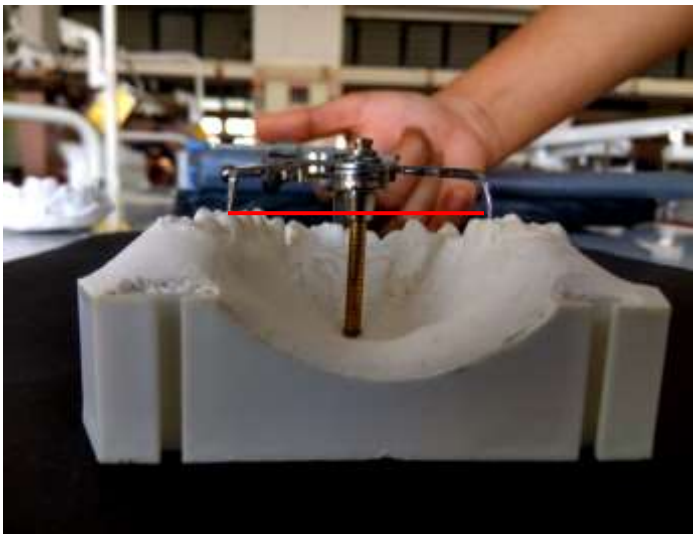

Figure 3: Measurements being taken on the cast