

ORIGINAL ARTICLE

A COMPARATIVE EVALUATION OF THE INTER-RELATIONSHIP BETWEEN INNER-CANTHAL DISTANCE, INTER-ALAR WIDTH AND INTER-PUPILLARY DISTANCE WITH RESPECT TO INTERCANINE WIDTH AMONGST THE POPULATION OF HIMACHAL PRADESH

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ABSTRACT:

Background: The face is the most visible and expressive part of human anatomy and it is the face which determines our social acceptance. Changing demographics, including an increase in life expectancy and the growing numbers of elderly, has recently focused attention on the need for geriatric dental care. One of the most confusing and difficult aspects of complete denture prosthodontics is the selection of appropriately sized maxillary anterior teeth when pre-extractions records are not available. Hence the study has been taken to determine the exact relationship that exists between inner-canthal distance, inter-alar width, inter-pupillary distance and the combined width of maxillary six anterior teeth. **Materials & Methods:** This hospital-based prospective observational study was conducted in 40 healthy dentate subjects in the Department of Prosthodontics, Himachal Pradesh Government Dental College and Hospital, Shimla (Himachal Pradesh), India. Out of the 40 subjects, 20 (50%) were males and 20 (50%) were females. Inner-canthal distance (ICD), inter-alar width (IAW), interpupillary distance (IPD) and inter-canine width (ICnW) were measured using a digital vernier caliper. All the results were analyzed by SPSS software. **Results:** Correlation of inter canine distance with inner-canthal distance, inter-alar width and inter-pupillary distance among overall sample showed statistically significant very strong positive relationship. **Conclusion:** Inner canthal, inter-alar, inter-pupillary landmarks can be used as the anatomical landmark to select the maxillary anterior teeth in the absence of the pre-extraction records.

Key words: Alar, Inner-Canthal, Landmark

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INTRODUCTION

It was once written that we greet the world with our faces.¹ The face is the most visible and expressive part of human anatomy and it is the face which determines our social acceptance.^{1,2} Loss of teeth not only affects facial appearance but also leads to psychological trauma to the person, hence it is essential that an esthetically pleasing and functionally comfortable replacement of teeth should be provided.² Changing demographics, including an increase in life expectancy and the growing numbers of elderly, has recently focused attention on the need for geriatric dental care.³ Himachal Pradesh has 7 lakh persons aged 60 years and above, constituting 10.2% of its total population, which is higher than the national average of 8.6% (Census 2011).

Between 1991 and 2011, overall population in the state increased 37%; the 60+ population increased 67%; and the 80+ which is the fastest growing age segment, increased by 87%. The elderly population is estimated to grow 3.1% annually and is expected to reach 1.1 million by 2026, which would be about 15% of the state's total population by that year.⁴ This implies that the demand for restoration of edentulous patients will remain high for the foreseeable future.⁵

One of the most confusing and difficult aspects of complete denture prosthodontics is the selection of appropriately sized maxillary anterior teeth when pre-extractions records are not available.^{6,7} While various methods may enable dentists to select teeth that are generally suitable for patient, the most esthetic result is probably obtained by the dentist

who believes that anterior teeth selection is as much an art as it is a science.⁸ Tooth width is considered more crucial than length.^{9,10,11} Mortone has pointed out that for pleasing esthetics, a proportionate relationship between the teeth and other facial does exist.¹² Considering that width of nose would not show any changes after the extraction of teeth, it was decided to use this landmark for getting the relationship with the width of the teeth.^{2,13}

Analysis of the measurement showed that the inner canthal distance or the Inter-Alar distance may be used as alternative predictor for the estimation of the Inter-Canine width of the maxillary six anterior teeth, when multiplied by a respective ratio of 1.61 and 1.45.² Another study suggested that there is a constant relationship between inter-pupillary distance and maxillary central incisor since the inter-pupillary distance remains fairly constant once the growth of individuals fully stops and may be use as a reference guide in determining the width of maxillary anterior teeth.^{9,14}

Further demographic variation may exist with repeat to anthropometric measurements.² An extensive review of literature revealed very few studies done in the Indian population and no such data existing for the population of Himachal Pradesh. Hence the study has been taken to determine the exact relationship that exists between inner-canthal distance, inter-alar width, inter-pupillary distance and the combined width of maxillary six anterior teeth.

MATERIALS AND METHODS:

This hospital-based prospective observational study was conducted in 40 healthy dentate subjects in the Department of Prosthodontics, Himachal Pradesh Government Dental College and Hospital, Shimla (Himachal Pradesh), India. Out of the 40 subjects, 20 (50%) were males and 20 (50%) were females.

Inclusion criteria were subjects born in Himachal Pradesh and residing here for last 15 years with permanent complete dentulous ideal arch form and alignment; with first and second molar fully erupted and in occlusion; class 1 ridge relation; who had not undergone any major oral surgical procedure; absence of any morphological and developmental anomalies(peg laterals, supernumerary teeth, mesiodens and retained deciduous teeth). Subjects non resident of Himachal Pradesh; history of orthodontic treatment; a Class II or Class III molar relationship; gingival inflammation and hypertrophy in the upper anterior region; severe attrition; crowns or proximal restorations placed in the anterior teeth; and a history of congenital anomaly, orbital disease, trauma, or facial surgery were excluded.

Approval for the study was obtained from Institutional Ethics Committee, Shimla. The subjects provided written informed consent.

Determination of the inner-canthal distance (ICD), inter-alar width (IAW), interpupillary distance (IPD) and inter-canine width (ICnW)

The various materials used for this study are shown in figure 1. The subjects were comfortably seated on a dental chair in a relaxed state in an upright position with the head resting firmly against the head rest. Both ICD and IAW were measured using digital vernier caliper. The ICD was measured from the medial angle to the medial angle of the palpebral fissure as shown in figure 2. The IAW was determined by using the external width of the nose at the widest point using digital vernier caliper, by bringing the recording parts of the caliper just in contact with the outer surface of the nose as shown in figure 3. For measuring the IPD participants were seated comfortably in an upright position and asked to look straight. The measurements were made from the mid pupil of one eye to mid pupil of other eye using a Boley gauge as shown in figure 4. ICnW was determined by placing circumferencing the floss along the curvature of the anterior dentition such that it passed along the contact point of all the teeth. The distal end of the canine teeth on both sides was then marked on the floss while it was taut in the patient's mouth. Floss was marked on both the distal sides with the marking pen and the distance between the two proximal contact points was measured by using vernier caliper and recorded as the ICnW as shown in figure 5(a) and 5 (b).



Figure 1: Materials used for the study (above below): digital vernier caliper, Boley gauge, dental floss, cheek retractor, black marker



Figure 2: Measurement of inner-canthal distance

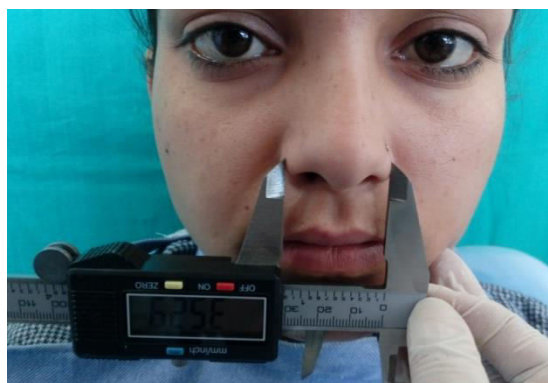


Figure 3: Measurements of inter-alar width

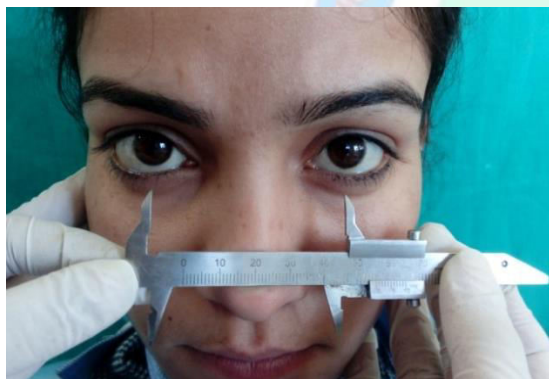


Figure 4: Measurement of inter-pupillary distance



Figure 5(a): Measurement of intercanine width (left)

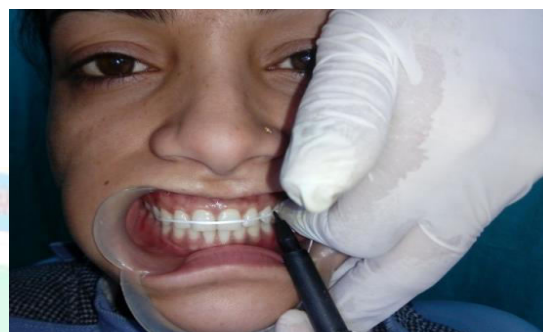


Figure 5(b): Measurement of intercanine width (right)

STATISTICAL METHODS

Collected data was applied for statistical analysis by statistician. Descriptive statistics were calculated (mean and standard deviation) and also tabular presentation was done. For inferential statistics, Pearson’s correlation coefficient was applied to find out significant correlations between the groups.

Table 1: Comparison of inter canthal distance, inter alar width, inter pupillary distance and inter canine distance between males and females

Parameter		Gender		Overall	Unpaired t-test value	P value
		Male	Female			
Inter canthal distance (mm)	Mean ± SD	33.30 ± 1.22	27.08 ± 3.01	30.19 ± 3.88	8.566	0.000 (< 0.001), Sig. diff.
	Min-Max	31.01 - 35.10	23.06 - 36.92	23.06 - 36.92		
Inter alar width (mm)	Mean ± SD	39.04 ± 2.21	31.34 ± 3.68	35.19 ± 4.92	8.026	0.000 (< 0.001), Sig. diff.
	Min-Max	35.64 - 44.29	22.69 - 39.66	22.69 - 44.29		
Inter pupillary distance (mm)	Mean ± SD	67.89 ± 3.08	61.00 ± 3.13	64.45 ± 4.65	7.007	0.000 (< 0.001), Sig. diff.
	Min-Max	61.50 - 72.51	53.71 - 68.49	53.71 - 72.51		
Inter canine distance (mm)	Mean ± SD	51.99 ± 2.63	45.76 ± 2.31	48.88 ± 3.99	7.946	0.000 (< 0.001), Sig. diff.
	Min-Max	46.95 - 57.25	41.31 - 51.53	41.31 - 57.25		

RESULTS

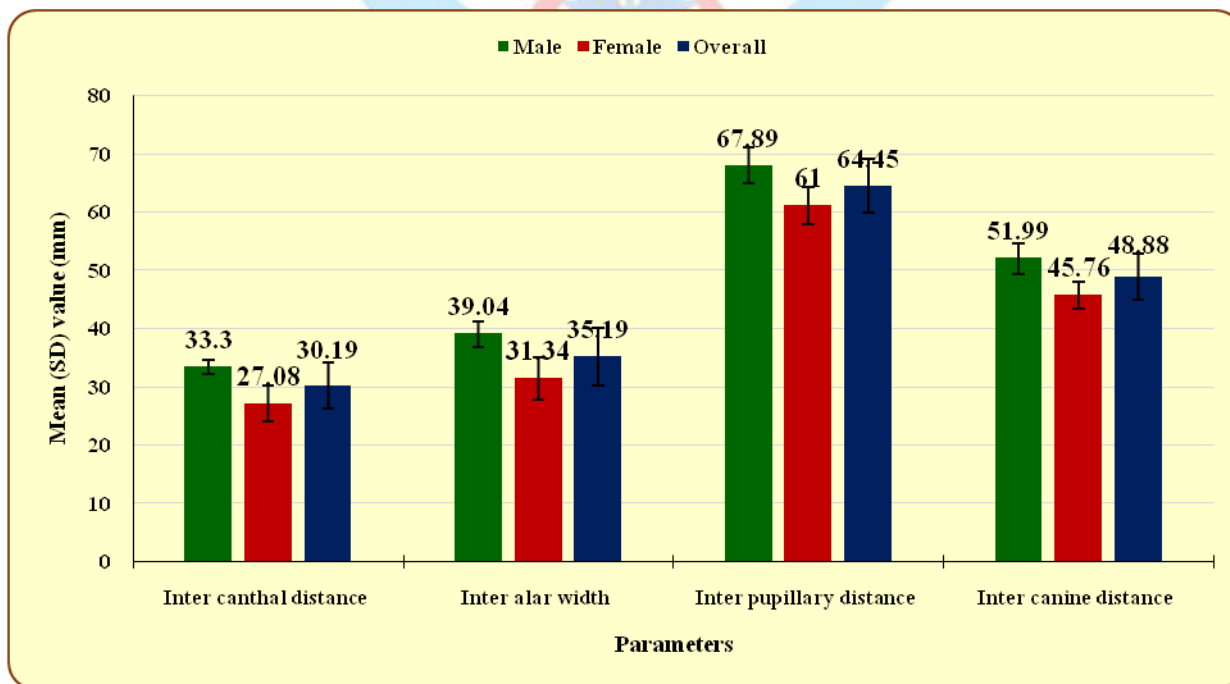
The mean mean values of ICD, IAW, IPD and ICnW in Himachal Pradesh population are presented in Table 1(graph1). Pearson’s correlation coefficients between ICD, IAW, IPD and ICnW in Himachal Pradesh population are

presented in Table 2 (graph2). Correlation of inter canine distance with inner-canthal distance, inter-alar width and inter-pupillary distance among overall sample showed statistically significant very strong positive relationship (P < 0.001)

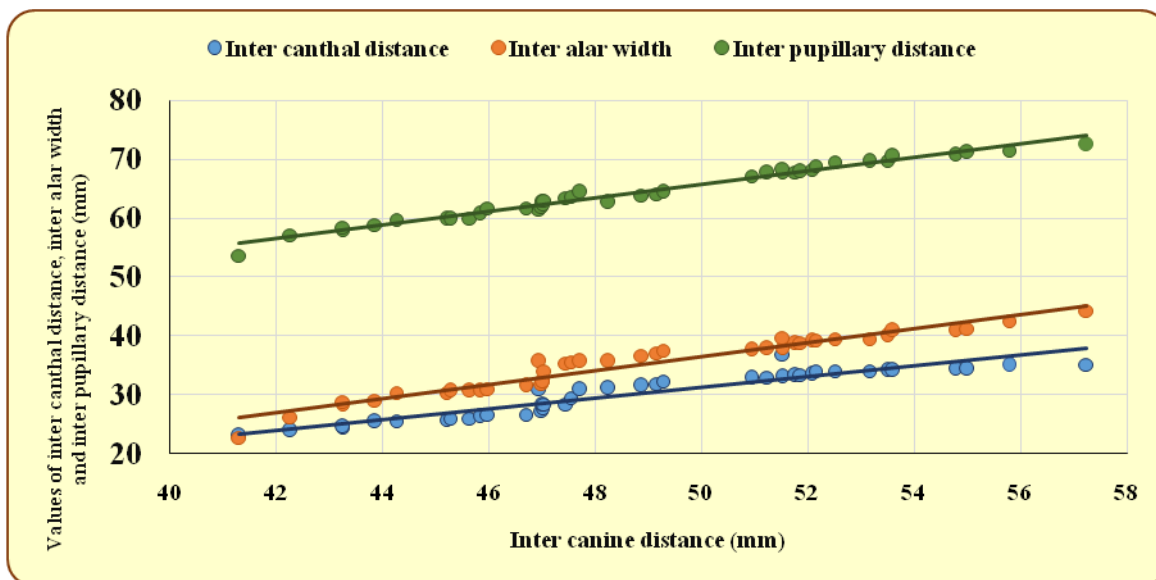
Table 2: Correlation of inter canine distance with inter canthal distance, inter alar width and inter pupillary distance in males, females and overall sample

Correlation of inter canine distance with			Pearson’s correlation coefficient	P value
Inter distance	canthal	Male	0.969 (Very strong positive relationship)	0.000 (< 0.001), Significant
		Female	0.933 (Very strong positive relationship)	0.000 (< 0.001), Significant
		Overall	0.944 (Very strong positive relationship)	0.000 (< 0.001), Significant
Inter alar width		Male	0.977 (Very strong positive relationship)	0.000 (< 0.001), Significant
		Female	0.957 (Very strong positive relationship)	0.000 (< 0.001), Significant
		Overall	0.970 (Very strong positive relationship)	0.000 (< 0.001), Significant
Inter distance	pupillary	Male	0.978 (Very strong positive relationship)	0.000 (< 0.001), Significant
		Female	0.980 (Very strong positive relationship)	0.000 (< 0.001), Significant
		Overall	0.988 (Very strong positive relationship)	0.000 (< 0.001), Significant

Graph 1: Comparison of inter canthal distance, inter alar width, inter pupillary distance and inter canine distance between males and females.



Graph 2: Correlation of inter canine distance with inter canthal distance, inter alar width and inter pupillary distance in overall sample.



DISCUSSION

Scandrett et al⁸ evaluated bizygomatic distance, inter-alar width, inter-commissural width, sagittal cranial diameter, inter-buccal frenulum distance, philtrum width, and age as predictors of the width of the maxillary anterior teeth and central incisors. The investigators concluded that no single predictor was accurate enough for clinical application. Therefore, it appears that more than one variable is needed to predict the width of the maxillary anterior teeth.⁵

The present study is based on the principle of Prosthodontics where different facial reference points are used to determine the width of anterior teeth and intercanine width for the purpose of teeth setting.¹⁵

This study was undertaken to determine the inter-relationship between the inner-canthal distance, inter-alar width, inter-pupillary distance with respect to inter-canine width in twenty males(50%) and twenty females(50%) belonging to the population of Himachal Pradesh.

The average inner canthal distance in males was 33.30 mm and in females was 27.08 mm. These values indicate that the inter canthal distance was lesser in females by 6.22 mm. This difference may be attributed to the smaller facial features in females. Other studies conducted in Gujarat by Patel et al² reported the mean values which were not corroborating and were larger than the present study for males (33.10 mm) and smaller for female (31.75mm) and the difference attributed to the measurements from different populations and races. Bozkir MG¹⁶ (2003) in his Turkish study found the mean value of inter canthal distance was 30.7 ± 3 mm in males and 30 ± 2.6 mm in females. The overall mean inner canthal distance in this study (30.19 mm) was similar

value reported by Laestdius et al in 1969 (30.00 mm).¹⁷ The measurements being recorded in population and races of different areas might be the reason for variation in the value.¹⁸

The average inter-alar distance in males in the study undertaken was 39.04 mm and in females 31.34 mm with an overall mean of 35.19 mm. The mean IAW (35.19 mm) of subjects with a range of 22.69 mm – 44.29 mm, was smaller than the values reported by Latta et al¹⁹ (43.93 mm with a range from 29.0 mm to 63.0 mm), Qamar et al²⁰ (35.46 mm) but was higher than the values reported by Smith⁷(33.5 mm), Abdullah et al.¹³ (34.0 mm), Hoffman et al.⁶(34.28 mm), Scandrett et al.⁸ (34.4 mm), al-el-Sheikh and al-Athel²¹ (33.27 mm), and Ibrahimagic et al²². (32.2 mm). The mean IAW was found to be almost similar to the values reported by Mavroskoufis and Ritchie²³ (35.3 mm). The mean IAW in present study was found to be higher in men (39.04 mm) compared to women (31.34 mm). The greater IAW seen in men reveals the influence of male dominance factor, as is also appreciable by the difference in size of jaws and teeth between the two sexes.¹⁸ These figures indicate that the interalar distance was lesser in females by an average of 7.7 millimeters. This difference may be attributed to the smaller facial features in females. The finding agrees with the statement made by Frush and Fisher,²⁴ Sicher²⁵ and Grey²⁶.

The average interpupillary distance in males was 67.89 mm and in females was 61.00 mm. This figure seems to show that the interpupillary distance was lesser in females by 6.89 mm. This difference may be attributed to the smaller facial features in females. The interpupillary distance is a facial landmark that is stable and does not modify after the

age of fourteen and remains fairly constant once the growth of the individual stops which makes it an excellent reference guide in determining the width of the maxillary anterior teeth.²⁷ Just similar to the present study Gomes VL et al conducted their study to find out the relationship of inter-pupillary and inter-canine distance, that could help in the selection of the denture teeth. They found out that the interpupillary distance could be used reliably for the selection of maxillary anterior teeth.²⁸ The measurement of interpupillary distance was also recorded by using vernier caliper as done by Abdullah MA.¹³ The mean of the interpupillary distance lower (59.16 mm) than the present study was reported by Cesario VA⁹, Latta GH.¹⁹ However high value of the mean was also reported by Gomes VL et al²⁶, Junior IL et al¹⁹. The variation in the values of the mean in various studies may be due to the ethnic and racial differences. However the results of some studies are in agreement with the results of the present study.²⁷

The average inter canine distance in males was 51.99 mm and in females was 45.76 mm. The figure seems to show that the inter canine distance was lesser in females by 6.23 mm. This difference may be attributed to the smaller facial features in females. In this study the mean combined width of the maxillary six anterior teeth was 51.99 mm in males and 46.95 mm in females. McArthur²⁹ in 1985 reported the mean of combined width of maxillary six anterior teeth was 54.6 mm in male and the mean value of inter canthal distance was 52.3 mm in female. The mean combined width of the maxillary six anterior teeth (48.88 mm) was more than the means reported by Hoffman et al⁶ in 1986 (44.85mm), Shillingburg et al³⁰ in 1972 (45.8mm) as they measured from the tip of right and left maxillary canines. Patel² in 2011 reported a mean combined width of the maxillary six anterior teeth was 53.51 mm in males and 50.73 mm in females. Hussain²⁷ in 2012 reported a overall mean of 46.01 which compares favourably with overall the mean found in this study (48.88mm). The difference in values can be attributed to the difference in race and ethnicity of the populations studied.²

Unpaired t-test showed significantly higher inner canthal distance in males than females ($t = 8.566, p < 0.001$), significantly higher inter alar width in males than females ($t = 8.026, p < 0.001$), significantly higher interpupillary distance in males than females ($t = 7.007, p < 0.001$) and significantly higher inter canine distance in males than females ($t = 7.946, p < 0.001$). The significantly higher values of all the studied parameters in males when compared with females can be attributed to the smaller facial features in females.

In the study presented here, Pearson's correlation coefficient for ICD, IAW, IPD and ICnW was found to be statistically significant, very strong positive relationship. Hence these parameters can be used to predict maxillary intercanine width especially when selecting teeth for complete dentures.

Comparing the results of previously reported studies, it is well understood that the differences in maxillary anterior teeth width are rooted primarily in ethnic and morphological characteristics of different population. Keeping in mind, the great individual variations in human physiology and morphological parameters, the application of inaccurate standards in the selection of maxillary anterior teeth would have lead to unsatisfactory and unaesthetic results of complete denture therapy.

Therefore, the results of specific relations of facial landmarks and width of anterior teeth must be perceived as distinctive features of the investigated population. The present study was conducted in a Himachal Pradesh population to determine the correlation between facial measurements and the combined width of maxillary anterior teeth.

The limitation of this study was resiliency of the soft-tissues. Hence additional studies are required where bony landmarks can also be taken as reference points, in which case, it will be perhaps more reliable. Another limitation is that, this study was carried out within the institutional set up and only 40 subjects belonging to the population of Himachal Pradesh were evaluated. Hence, the result may be applicable to just a small population. The results of the study should be validated by including a large population size spread over the entire Indian subcontinent. This would help to generate multiple factors for various anthropological measurements for use among the Indian population.

CONCLUSION

- 1) The inter-relationship between the inner canthal distance, inter-alar width, inter-pupillary distance with respect to inter-canine width was studied in twenty males and twenty females possessing normal occlusion having permanent complete dentulous ideal arch form and alignment with first and second molar fully erupted and in occlusion and class one ridge relation without any morphological and developmental anomalies
- 2) The mean interalar distance in males was 39.04 mm and in females 31.34 mm. The mean inter-pupillary distance in males was 67.89 mm and in females 61.00 mm. The mean inner canthal distance in males was 33.20 mm and in female 27.08 mm. The mean intercanine distance in males was 51.99 mm in males and in 45.76 mm in females
- 3) The difference of interalar and intercanine distances in males was 12.95 mm and in females 14.42 mm.
- 4) The difference of inter pupillary and intercanine distances in males was 15.9 mm and in females 15.24 mm.
- 5) The difference of inner-canthal and intercanine distances in males was 18.79 mm and in females 18.68 mm.

- 6) The interalar, inter papillary, inner canthal and intercanine width distances were more in males than in females, thus revealing an influence of sex factor
- 7) A definitive correlation between the interalar, interpupillary, inner canthal and intercanine distances was established
- 8) Inner canthal, inter-alar, inter-pupillary landmarks can be used as the anatomical landmark to select the maxillary anterior teeth in the absence of the pre-extraction records.

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