Extraction of maxillary canines: Esthetic perceptions of patient smiles among dental professionals and laypeople

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**Introduction:** Maxillary canines are generally considered important both cosmetically and functionally. Most claims on the importance of maxillary canines, however, have been based on expert opinions and clinician-based studies. There are no scientific studies in the literature reporting on their cosmetic importance or how laypeople perceive a smile treated by maxillary canine extractions. Our objective was to investigate whether there is any difference in the perceptions of patients' smiles treated by extracting either maxillary canines or first premolars, as judged by orthodontists, dentists, and laypeople. **Methods:** This retrospective study included 24 participants who had unilateral or bilateral extraction of maxillary permanent canines and fixed appliances in the maxillary and mandibular arches to comprehensively correct the malocclusion, selected from orthodontic patients treated at Chesterfield Royal Hospital NHS trust in the United Kingdom over the last 20 years. The control group of patients had extraction of maxillary first premolars followed by fixed appliances and finished to an extremely high standard judged by the requirement that they had been submitted for the Membership in Orthodontics examination. The finished Peer Assessment Rating scores for this group were less than 5. The end-of-treatment frontal extraoral smiling and frontal intraoral views were presented for both groups. The photographs were blinded for extraction choice and standardized for size and brightness using computer software (Adobe Photoshop CC version 14.0; Adobe Systems, San Jose, Calif). The work file was converted to an editable pdf file and e-mailed to the assessors. The assessor panel consisted of 30 members (10 orthodontists, 10 dentists, and 10 laypeople), who were purposely selected. The measures were rated on a 10-point Likert scale. **Results:** The attractiveness ratings were not statistically different between the canine extraction and premolar extraction groups, with a mean difference of 0.33 (SD, 0.29) points. A 1-way repeated-measures analysis of variance to test the difference in scores among the laypeople, orthodontists, and dentists (n = 30) showed no statistically significant difference (Wilks lambda = 0.835; P = 0.138), and the Bonferroni test indicated that no pair-wise difference was statistically significant. **Conclusions:** No statistically significant difference was found in the smile attractiveness between canine extraction and premolar extraction patients as assessed by general dentists, laypeople, and orthodontists. Further high-quality studies are required to evaluate the effect of canine extraction and premolar substitution on functional occlusion. (Am J Orthod Dentofacial Orthop 2017;152:509-15)

Maxillary canines are infrequently extracted for orthodontic treatment, since these teeth are considered important both cosmetically and functionally. The concept of canine-guided occlusion is often claimed to be the optimal type of functional occlusion for the natural dentition. It is also firmly believed by some that orthodontists who do not establish a canine-guided occlusion may predispose patients to temporomandibular disorders. 1,2 The evidence for this claim, however, is scarce. Weinberg3 showed that 81% of a sample with an untreated natural dentition had a group function, whereas only 5% had a canine-protected occlusion. This has been reinforced by other researchers. 4-11 It has also been shown that canine-guided occlusion
is a popular choice for orthodontic and prosthodontic rehabilitation. Interestingly, a recent study on congenitally missing lateral incisors and space closure concluded that substitution of first premolars for canines does not incur any risk for temporomandibular disorders in the long term.

Canines are also considered extremely important for cosmetic appearance. Wheeler described canines as “a foundation that insures normal facial expression.” Furthermore, Dewel emphasized the importance of canines as “indispensable for maintenance of harmony and symmetry of occlusal relationships.” The evidence for these claims, however, is scarce. In a study of 56 cases, Senty et al reported that the first premolar can serve as an adequate substitute for the canine, both functionally and esthetically. With the lack of convincing evidence for both functional and cosmetic importance of canines, the philosophy of canine “sanctity” may indeed have been an exaggeration of the real situation.

There are undeniably many situations when maxillary canines must at least be considered candidates for extraction: eg, a patient with an ectopically placed maxillary permanent canine with a severe arch-length discrepancy where the first premolar has almost completely replaced the erupted canine. Even though canine surgical removal is by far the quickest and simplest approach, and often in the best interest of patient, parent, and orthodontist, we still opt for extraction of first premolars to heroically align the impacted canines. This clinical scenario creates something of a dilemma for a clinician practicing in the present climate of evidence-based dentistry.

Most of the claims on the importance of the maxillary canines have been based on expert opinions and clinician-based studies. There are no scientific studies in the literature reporting on the cosmetic importance of canines or how laypeople perceive a smile treated by maxillary canine extractions.

Our aim in this study was to investigate whether there is any difference in the perceptions of patients’ smiles treated by extracting either maxillary canines or premolars, as judged by orthodontists, dentists, and laypeople.

Our hypothesis was that there is no difference in the perceptions of patients’ smiles treated by extracting either maxillary canines or premolars, as judged by orthodontists, dentists, and laypeople.

MATERIAL AND METHODS

This was a retrospective study in which participants were recruited from orthodontic patients treated at Chesterfield Royal Hospital in the United Kingdom over the last 20 years. The inclusion criteria for the
treatment group were patients who had unilateral or bilateral extraction of maxillary permanent canines followed by fixed appliances in the maxillary and mandibular arches to comprehensively correct the malocclusion.

Exclusion criteria were syndromic patients, patients with single-arch treatment, and patients who failed to complete the full course of orthodontic treatment.

Patients in the canine extraction group were matched with patients who had unilateral or bilateral extraction of maxillary first premolars followed by maxillary and mandibular fixed appliances for the treatment of their malocclusion. We selected a control group of patients who had been finished to an extremely high standard. The finished Peer Assessment Rating scores were less than 5 for this group. No cosmetic restorative work was carried out for any patient. Institutional approval was obtained from Chesterfield Royal Hospital NHS trust.

End-of-treatment photographic records were obtained for both groups. The photographs were standardized using computer software (Adobe Photoshop CC version 14.0; Adobe Systems, San Jose, Calif) for size and brightness. For each patient, frontal extraoral smiling and frontal intraoral views were presented. The images were cropped, rescaled, and pasted into a word file. The photographs were blinded as to the extraction choice, and a random number was assigned for blinded analysis by a researcher (B.T.). Samples of photographs of patients in the canine extraction group and the premolar extraction group are shown in Figures 1 and 2, respectively. The Word file was converted to an editable pdf file and e-mailed to the assessors.

The 30 members of the rating panel, who were purposely selected, comprised 10 orthodontists, 10 dentists, and 10 laypeople. The laypeople were adult volunteers from Chesterfield Royal Hospital NHS trusts. None of the assessors were involved in the care of the patients included in the study. The assessors were asked to rate the photographs according to the attractiveness of the patient’s smile. The measures were rated on a 10-point Likert scale.

Fig 2. Sample photographs for premolar extraction treatment.

Table I. Agreement of 12 judges’ repeat assessments including mean differences, standard deviations, 95% confidence intervals, P value, and intraclass correlation coefficient (ICC)

<table>
<thead>
<tr>
<th>Judges</th>
<th>Mean difference</th>
<th>SD of difference</th>
<th>Lower bound</th>
<th>Upper bound</th>
<th>P value</th>
<th>ICC</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>0.25</td>
<td>1.28</td>
<td>−1.06</td>
<td>0.56</td>
<td>0.515</td>
<td>0.728</td>
</tr>
</tbody>
</table>
The Likert scale from 1 to 10 was selected over the visual analog scale for logistical reasons. Jaeschke et al.\(^\text{17}\) showed, however, that both methods of presenting the response data have the same levels of validity and responsiveness. In this study, high scores indicated an unattractive smile. A reliability assessment was carried out for 12 assessors (4 in each group) with at least a 4-week interlude to minimize recall bias and fatigue.

**Statistical analysis**

Data were entered into an Excel spreadsheet (2007; Microsoft, Redmond, Wash), and SPSS software (version 18; SPSS, Chicago, Ill) was used for the statistical tests. Because the 10-point Likert scale was used with the intervals between points considered approximately equal (the underlying concept was continuous), parametric tests were used in this study.\(^\text{18}\) The distribution of the data was examined and found to be normally distributed. The reliability was assessed using a paired \(t\) test for systematic error and intraclass correlation coefficients for random errors.

### RESULTS

Forty-eight patients (32 female, 16 male) were included in this study: 24 in the treatment group and 24 in the control group. The canine extraction group included 14 with unilateral extraction and 10 with bilateral extraction. The photographs were assessed by 6 specialist orthodontists, 6 general dentists, and 6 laypeople on 1 occasion, and by 4 specialist orthodontists, 4 general dentists, and 4 laypeople on 2 occasions. The level of agreement for the 12 judges on the smile attractiveness between the canine extraction and premolar extraction groups is shown in Table I. The mean difference was 0.25, suggesting low systematic error. The random error showed substantial agreement (intraclass correlation coefficient, 0.728).

The mean scores for the assessors’ judgments of the 2 groups were generated from the Likert scale for smile attractiveness. The following rater groupings were made: professionals and laypeople. The professionals were subdivided into dentists and orthodontists. One-way analysis of variance (ANOVA) was used to compare the groups’ scores, with \(P\) values of 0.05 or less considered statistically significant.

### Table II. Mean difference and confidence intervals of the differences in scores between the canine extraction and premolar extraction groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean difference</th>
<th>SE of difference</th>
<th>95% CI</th>
<th>(P) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canine vs premolar extraction</td>
<td>0.33</td>
<td>0.29</td>
<td>-0.26</td>
<td>0.91</td>
</tr>
</tbody>
</table>

The mean scores for the assessors’ judgments of the 2 groups were generated from the Likert scale for smile attractiveness. The following rater groupings were made: professionals and laypeople. The professionals were subdivided into dentists and orthodontists. One-way analysis of variance (ANOVA) was used to compare the groups’ scores, with \(P\) values of 0.05 or less considered statistically significant.

### Table III. Mean differences and confidence intervals for overall scores among assessors

<table>
<thead>
<tr>
<th>Assessors</th>
<th>Mean difference</th>
<th>SE of difference</th>
<th>Lower bound</th>
<th>Upper bound</th>
<th>(P) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laypeople</td>
<td>0.231</td>
<td>0.34</td>
<td>-0.46</td>
<td>0.92</td>
<td>0.675</td>
</tr>
<tr>
<td>Orthodontists</td>
<td>0.51</td>
<td>0.30</td>
<td>-0.09</td>
<td>1.11</td>
<td>0.094</td>
</tr>
<tr>
<td>General dentists</td>
<td>0.230</td>
<td>0.31</td>
<td>-0.41</td>
<td>0.86</td>
<td>0.477</td>
</tr>
</tbody>
</table>

The mean scores for the assessors’ judgments of the 2 groups were generated from the Likert scale for smile attractiveness. The following rater groupings were made: professionals and laypeople. The professionals were subdivided into dentists and orthodontists. One-way analysis of variance (ANOVA) was used to compare the groups’ scores, with \(P\) values of 0.05 or less considered statistically significant.

### Table IV. Follow-up comparisons using the Bonferroni test

<table>
<thead>
<tr>
<th>Assessor Group</th>
<th>Mean difference</th>
<th>SE of difference</th>
<th>Lower bound</th>
<th>Upper bound</th>
<th>(P) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laypeople</td>
<td>0.230</td>
<td>0.31</td>
<td>-0.41</td>
<td>0.86</td>
<td>0.477</td>
</tr>
<tr>
<td>Orthodontists</td>
<td>0.510</td>
<td>0.30</td>
<td>-0.09</td>
<td>1.11</td>
<td>0.094</td>
</tr>
<tr>
<td>General dentists</td>
<td>0.230</td>
<td>0.31</td>
<td>-0.41</td>
<td>0.86</td>
<td>0.477</td>
</tr>
</tbody>
</table>

The mean scores for the assessors’ judgments of the 2 groups were generated from the Likert scale for smile attractiveness. The following rater groupings were made: professionals and laypeople. The professionals were subdivided into dentists and orthodontists. One-way analysis of variance (ANOVA) was used to compare the groups’ scores, with \(P\) values of 0.05 or less considered statistically significant.
DISCUSSION

Our results showed no statistically significant difference in the smile attractiveness of patients treated with canine extractions or premolar extractions. The dental professionals did not rate the photographs any different than did the laypeople.

Esthetics is the primary consideration for patients seeking orthodontic treatment. The size and form of the anterior maxillary teeth are important not only for dental esthetics but also for facial esthetics. Previous studies have indicated that the most harmonious smile is the one with the golden proportions. Several authors, however, have conflicting views and have reported that most beautiful smiles do not follow the golden proportions. The substitution of the first premolar for the canine will, of course, have an impact on the golden proportions. In this study, even though the premolar was substituted for the canine, this had no impact on the overall smile attractiveness as perceived by the 3 groups of assessors.

The size difference between the maxillary canines and the first premolars can theoretically create a poor esthetic balance when the canines are substituted for premolars. In general, maxillary canines have longer crown heights than do first premolars. This could result in an undesirable gingival margin height. Correa et al. investigated the perceptions of maxillary canine gingival margin asymmetries and found that gingival margin asymmetries up to 2.0 mm were not detected by laypeople. However, the orthodontists were more rigorous and detected an asymmetry above 0.5 mm. In this study, although the assessment by laypersons was in line with the previous study, the results from the orthodontists were contrary. It is interesting that orthodontists did not rate the canine extraction patients any different than those who had premolar extractions. This could be due to the difference in the sample size. Correa et al used 6 digitally altered images, and our study included 48 patient photographs.

Pinho et al. investigated the perceptions of incisal edge asymmetries between maxillary canines and reported that discrepancies up to 2 mm were not detected by orthodontists, dentists, or laypersons. The results concur with our study, since the assessors’ scores were not significantly different between the premolar and canine extraction groups. No group of assessors in our study detected this type of smile asymmetry when evaluating the frontal photographs. This discrepancy, however, might be perceivable on profile and oblique photographs, in which the canine tends to gain relative esthetic importance.

An interesting aspect of this study was the reliability assessment. Most studies did not report on reliability measurements, probably because rating the photographs is a subjective evaluation. The need for reliability assessment is especially important in these types of studies because of the involvement of multiple assessors and the potential for variability. Indications of high agreement can provide confidence in the conclusions of the studies. This study showed substantial agreement in the intra-class correlation coefficient for the reliability assessment.

No studies on the esthetic impact of premolar replacements for canines were found in the literature. Furthermore, no studies were found on the functional impact of premolar replacement. This study is the first to report on the assessment of smile attractiveness of these patients. Further research is needed in this area to promote evidence-based practice and also to inform patients of the treatment options with clear information on risks and benefits so that they can make an informed decision.

This study was conceived from the clinical question “is it worth struggling to align palatally impacted canines that are close to the midline or extremely high and horizontal?” The results from this study provide evidence that there is no major cosmetic benefit from aligning the maxillary canines. Furthermore to date the evidence for the cosmetic benefit for aligning canines is non-existent. This study suggests that aligning canines is not the only way to achieve the best cosmetic results. The results from this study can be used to discuss all the options with our patients and their parents, so that they can make a truly informed decision.

Table IV. Bonferroni comparison for overall scores between assessors

<table>
<thead>
<tr>
<th>Assessors (I)</th>
<th>Assessors (J)</th>
<th>Mean difference (I-J)</th>
<th>SE</th>
<th>Significance*</th>
<th>95% CI for difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laypeople</td>
<td>Orthodontists</td>
<td>0.379</td>
<td>0.208</td>
<td>0.245</td>
<td>-0.159 0.917</td>
</tr>
<tr>
<td>Dentists</td>
<td>Orthodontists</td>
<td>0.462</td>
<td>0.217</td>
<td>0.132</td>
<td>-0.098 1.023</td>
</tr>
<tr>
<td>Orthodontists</td>
<td>Laypeople</td>
<td>-0.379</td>
<td>0.208</td>
<td>0.245</td>
<td>-0.917 0.159</td>
</tr>
<tr>
<td>Dentists</td>
<td>Laypeople</td>
<td>0.083</td>
<td>0.121</td>
<td>1</td>
<td>-0.229 0.396</td>
</tr>
<tr>
<td>Dentists</td>
<td>Orthodontists</td>
<td>-0.083</td>
<td>0.121</td>
<td>1</td>
<td>-0.396 0.229</td>
</tr>
</tbody>
</table>

*p <0.05.
One of the main limitations of this study was the lack of power calculation. Because the number of patients in our data base was limited, a power calculation was not carried out. All patients who had undergone canine extraction accompanied by fully comprehensive orthodontic treatment over the last 20 years at Chesterfield Royal Hospital NHS trust were included.

When we used the actual data from the study to retrospectively determine the sample required to show a significant difference, 20 patients per group (39 patients in total) were required for power of 80% and a significance level of 0.05. The other drawback was that we did not investigate the functional benefits of the canines. No canine extraction patients, however, attended the department at any time over the 20 years with any complaints of temporomandibular joint dysfunction or occlusal problems. No effort was made to contact the patients to assess function. In this study, unilateral and bilateral extraction patients were combined in the treatment group. Since the aim of the study was to determine whether there was any difference in the perceptions of the panel on the appearance of the anterior teeth after the extraction of canines or premolars, we did not attempt to measure the perceptions for bilateral or unilateral extractions. This is because we wanted to reflect the real-world situation where asymmetric extractions are carried out. We only looked at the smile esthetics from the frontal photographs. A difference could have been perceived on three-quarters smiling or intraoral buccal photographs in which the canines tend to be more noticeable.

CONCLUSIONS

1. No statistically significant difference was found in the smile attractiveness between canine extraction and premolar extraction patients as assessed by general dentists, laypersons, and orthodontists.
2. The orthodontists were marginally more critical in their evaluations, but their results were not statistically different from those of laypersons and general dentists.
3. Canine extraction should be discussed as a possible treatment option where this approach has distinct advantages.
4. Further high-quality studies are required to evaluate the effect of canine extraction and premolar substitution on functional occlusion.

REFERENCES


