

**ORTHODONTISTS', SENIOR DENTAL STUDENTS' AND LAYPERSONS'
PERCEPTIONS OF ESTHETICS OF PATIENTS TREATED
ORTHODONTICALLY WITH MAXILLARY CANINE
SUBSTITUTION, MAXILLARY PREMOLAR
SUBSTITUTION AND LOWER
INCISOR EXTRACTION**

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ABSTRACT

Introduction: Orthodontic treatment can camouflage the unesthetic dental problems such as, congenitally missing teeth, impacted teeth, skeletal-dental discrepancies, or a combination (Canut, 1996; Chawla et al., 2011). Orthodontic canine substitution is a procedure performed on patients with missing lateral incisors. This is a viable option for patients who elect not to prosthetically restore the missing teeth. In the process, canine teeth are moved into the lateral teeth positions, and the premolar teeth are positioned next to the canines (Kokich & Kinzer, 2005; Mazzini & Torres, 2017). Premolars may replace canines in conditions of impacted or untreatable pathological canines, where the impacted canines are determined to interfere with the development of adjacent teeth, or when the success of surgical exposure and orthodontics is unpredictable (Chawla et al., 2011). Similarly, lower incisors may be extracted and orthodontically replaced by adjacent teeth in to camouflage skeletal discrepancies, eliminate a Bolton discrepancy, relieve edge-to-edge anterior occlusion, correct Class III malocclusion, or to eliminate a severely blocked-out incisor (Bayram & Ozer, 2007). This study aims to investigate how different groups of individuals perceive the esthetic results of such treatments.

Materials and Methods: A survey was administered to 15 orthodontists, 15 senior dental students and 15 laypeople via iPad. The survey requested subject gender and ethnicity, and used a Likert scale to rate the esthetics of different images of dentition post-treatment (3 canine substitution, 3 premolar substitution, 3 lower incisor extraction, and 3 control images of non-extraction dentition post-treatment). The Likert scale used was a continuous sliding scale from 0-10. Post-treatment photographs chosen utilized the frontal view in maximum intercuspation of patients who were treated at Temple University's

Orthodontics Clinic. Median scores were compared across groups using Kruskal-Wallis tests.

Results: There were no significant differences across all three groups of subjects' median ratings for all four types of treatment. There were no significant differences in preferences between genders and ethnicities. For all median ratings except for Canine 2 and Canine 3, all male scores were higher than female scores. For two of three canine images, females rated them higher than males. The image with the overall highest median rating across all subjects was Control 1. The camouflage treatment image with the overall highest median rating is Premolar 3. The camouflage treatment image with the overall lowest median rating is Canine 3. Though, none of these differences were significant.

Conclusion: Orthodontists, senior dental students, and laypeople had no specific esthetic preferences. Orthodontic treatment outcomes were equivocally satisfactory for all surveyed subjects. Gender and ethnicity did not influence the degree of satisfaction. The orthodontist scores reflected their knowledge of the complexity of the case, whereas, the dental students paid attention to gingival margin heights and midlines, and color and shape of teeth. Straightness of teeth was preferred by the laypeople. Orthodontic camouflage treatment outcomes were equivocally satisfactory for all surveyed orthodontists, senior dental students, and laypeople, and there were no significant differences across all subjects' median ratings.

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CHAPTER 1

INTRODUCTION

Orthodontists aspire to create the best possible esthetic results for those who are congenitally missing upper lateral incisors, have impacted upper canines too severe to bring into occlusion, or require camouflaging of a Class III skeletal malocclusion with a lower incisor extraction. These three separate treatment plans are types of camouflage – the substitution of canines for laterals, the substitution of premolars for canines, and the extraction of a lower incisor therapeutically (Canut, 1996). All three therapeutic modalities are designed to deliver the optimal result, as the ideal result is not possible. These three separate camouflage treatments offer more affordable and less invasive means to manage complex cases.

Maxillary lateral incisors are the second most commonly missing teeth, following the mandibular second premolars (Alkadhimi, et al., 2022). In the treatment of missing upper lateral incisors, there are three treatment options for the patient: restoration of the lateral incisors with single-tooth implants, restoration of the lateral incisors with a tooth-borne restoration such as a Maryland bridge, or substitution of the canines for lateral incisors, with contouring of the facial surface to create a likeness of lateral incisor shape (Kokich & Kinzer, 2005). Premolar substitution, however, may be indicated for impacted canines, which were extracted before any attempts were made to bring them into the arch. Maxillary canines are fundamental in smile and facial esthetics for three reasons: They form the canine eminences for alar base and upper lip support, they participate in canine guidance to disarticulate the posterior teeth during lateral excursions, and they create esthetically pleasant anterior dentition proportions to create attractive smile lines.

Although the ideal treatment for an impacted canine is achieved by combining surgery and orthodontics when clinically possible, premolar substitution offers a great alternate option that is less invasive and can achieve similar esthetic and functional results (Chawla et al., 2011; Mirabella et al., 2013).

Lower incisor extractions are indicated in five different scenarios: Supernumerary anterior teeth; presence of a Bolton discrepancy; severe ectopic eruption of an incisor; Class III dental relationships; or edge-to-edge anterior occlusion (Bayram & Ozer, 2007; Canut, 1996). Extraction of one mandibular incisor is not always considered popular within the specialty of orthodontics. There are unwanted final result outcomes including: Increased overjet, relapse with space opening, finishing slightly Class III canine relationship, non-coincident midlines, and interproximal papillae loss (Bayram & Ozer, 2007; Canut, 1996; Maxxini & Torres, 2017). An adjunctive resource to determine whether this extraction pattern is of value is to create a diagnostic setup to assess the esthetics and occlusion of the final results (Bayram & Ozer, 2007; Canut, 1996).

These three orthodontic treatment modalities may yield less desirable esthetic results than orthodontically treated patients without camouflage or substitutions. Some factors that influence this treatment choice include esthetics, function, occlusion, cost, and treatment time. This study will investigate how the three groups of participants rate the overall esthetics of these chosen treatment plans. Our conclusion may be expected to aid the decision-making process in such complex conditions. Although the process of decision-making is individual, our recommendations may be expected to offer a platform for the patient and the orthodontist.

CHAPTER 2

REVIEW OF THE LITERATURE

2.1 Lower Incisor Extraction

2.1a Indications

In orthodontics, tooth extractions to achieve certain goals is not a novel concept. Extracting a lower incisor is a viable alternative for those malocclusions that do not fit conventional premolar extraction patterns (Bahreman, 1977; Mallavarapu et al., 2015). There are several indications to extract a lower incisor in orthodontics (Rathika and Ragavendra, 2015). They include: 1) Severe anterior tooth size discrepancy greater than 4.5mm (mandibular excess or maxillary deficiency), 2) severe lower anterior crowding with good posterior sagittal interdigitation, 3) anterior crossbites with protruded lower incisors, 4) camouflaging Class III dental and/or skeletal malocclusions, 5) supernumerary lower incisors, 6) treatment of adults with lower incisor relapse, 7) no desire to improve facial profile esthetics, and 8) a periodontally-compromised lower incisors where their maintenance would not offer stable and healthy dentition (Rathika & Ragavendra, 2015; Mallavarapu et al., 2015). A diagnostic setup is an essential part of treatment planning a lower incisor extraction case. They reveal the likely occlusion after extraction and space closure, and can be done manually on patient study models, or digitally through various softwares (Mallavarapu et al., 2015).

2.1b Contraindications

It is contraindicated to extract a lower incisor without a diagnostic setup. Lower incisor extractions are contraindicated in patients with deep bites and excessive overjet, horizontal growth patterns, bimaxillary dentoalveolar protrusion without a Bolton

discrepancy in the anterior region, and cases with a Bolton discrepancy of maxillary anterior excess or mandibular anterior deficiency (Bahreman, 1977). It is also contraindicated in patients with triangular-shaped lower incisors with less than 3mm of crowding. These patients should be treated with interproximal reduction to avoid black triangles and compromised esthetics. If a patient presents with any of the listed contraindications, or none of the listed indications, it would behoove the clinician to explore alternative treatment options. If the diagnostic setup demonstrates excessive overbite, overjet or unacceptable sagittal occlusion, a lower incisor extraction should not be the treatment of choice (Matsumoto et al., 2010)..

2.1c Esthetics

The midline goal of a lower incisor extraction is for the maxillary midline to coincide with the middle of the middle incisor. It is not believed that the mandibular dental midline affects esthetics (Valinoti, 1994). In a previous study by Pithon et al. comparing midline esthetics of a lower incisor extraction case compared to a control, only the dental students and dental professionals participating were able to notice midline differences between photographs, while only 36.7% of laypersons were able to notice differences (Valinoti, 1994).

2.1d Which Incisor?

After the clinician has decided the best treatment plan is to extract a lower incisor, it is essential to make the additional decision as to which incisor is best to extract. One must consider the amount of arch crowding, the malocclusion, the Bolton ratio, periodontal status and the upper and lower midlines. The Bolton analysis will reveal the individual tooth widths and help determine if it is wiser to extract a wider or narrower

tooth. Some clinicians prefer the narrower, assuming that there will be less space-opening relapse in a case with less crowding. Others prefer extractions of lateral incisors as the distal contact of the central incisor with the mesial contact of the canine will have less of a black triangle, compared to extraction of a central incisor (Mallavarapu, 2015).

2.2 Canine Substitution

2.2a Indications

Three different treatment options exist for patients congenitally missing lateral incisors. They include canine substitution, tooth-supported restorations, or single-tooth implants. Choosing the appropriate treatments depends on the severity of the malocclusion, the possibility of achieving functional occlusion and esthetics (Kinzer & Kokich, 2005). The most influential factor in the treatment planning decision is conservatism. The indications for canine substitution based on dentoalveolar occlusion include: 1) Angle Class II malocclusion with no crowding in the mandibular arch, and 2) Angle Class I malocclusion with mandibular crowding severe enough to warrant extractions. The indications based on overall case selection include: 1) A straight or mildly convex profile, 2) canines that are narrow at the cemento-enamel junction and possess a brighter shade and a flat labial surface, and 3) a low lip level with decreased gingival display upon smiling (Datta, 2021).

Canines can also be substituted for lateral incisors that are not congenitally missing. Patients with blocked-out lateral incisors and microdontia (“peg laterals”) can also be candidates for canine substitution (Kinzer & Kokich, 2005).

2.2b Contraindications

Although canine substitution serves as an orthodontic alternative to solve a complex malocclusion, literature advises clinicians to avoid this treatment option in patients with moderately-to-severely convex or concave profiles, moderate-to-severe Class II or Class III malocclusion, and moderate-to-severe vertical or transverse dentoalveolar or skeletal discrepancies (Al-Jewair & Swiderski, 2018).

Additional considerations such as periodontal status, implant candidacy, patient age and finances should be considered before making a final treatment decision (Al-Jewair & Swiderski, 2018; Schneider et al., 2016).

2.2c Esthetics

Bracket placement can contribute to the esthetic outcome of canine substitution. Orthodontists should bond brackets more gingival to permit extrusion, and movement of the gingival zenith to be more incisal to the central incisor. As the canine extrudes, the orthodontist will need to periodically perform enameloplasty on the canine cusp tip to avoid interferences with the lower incisors, and enhance the anatomy of the tooth to look more like a lateral incisor.

There may be an additional need to slenderize the canines interproximally to permit esthetic and ideal interproximal contacts and tooth dimensions. After ideal alignment and space closure, the patient may need additional bleaching, restorations (veneers or composite resin), or additional crown contouring (Kokich & Kinzer, 2005).

2.3 Premolar Substitution

2.3a Indications

Impacted maxillary canines are a frequent challenge for orthodontists and other specialists. They are the most-frequently impacted teeth, second to third molars. Impacted canines are also twice as common in females than males and twice as common in the maxilla than mandible. Canines play an essential role in smile esthetics, supporting the alar base and the upper lip. Canines also serve an important function during lateral excursions of the jaw to disocclude posterior teeth. When a clinician diagnoses an impacted canine, it is important to evaluate proximal anatomy for root resorption and any pathology. The clinician should also evaluate the achievability of successful treatment of the impacted canine. Impacted canine extractions are indicated for cases with poor prognoses. These include: 1) very deep impactions, 2) an impacted canine with a fully-formed root with dilaceration, 3) severe crowding and no room for eruption, and 4) when the canine position is positioned unfavorably. Seriously impacted canines may form a peri-coronal follicular cysts around the canine crown which can cause the proximal blood vessels to compress and periodontal attachment to be damaged. Impacted canines can also damage adjacent roots. When a combination of these conditions exist, extractions of the impacted maxillary canines would be a viable alternative to a lengthy, invasive, challenging, and potentially unrealistic treatment of extruding and guiding the canines into the dental arch (Cruz, 2019).

2.3b Esthetics

The maxillary first premolar has shorter roots than maxillary canine roots which could place the free gingival more occlusal than the canines' ideal margins aligned with

the central incisors. Orthodontic intrusion to move the gingival margin more apically, and addition of composite bonding or veneers could rectify the esthetic deficiency. Adding slight lingual crown torque to the premolars will help produce the ideal torque of canines. This can also be achieved by placing a canine bracket on the premolars (Mirabella et al., 2013; Cruz, 2019).

2.3c Premolar Guidance

According to Thoraton et al. there is no evidence of a superior occlusal scheme comparing canine guidance and premolar substitution. It is documented in the literature that premolar guidance can sufficiently supply canine guidance, or group function occlusion if the maxillary premolar is slightly extruded. It may be necessary to reduce the lingual cusp of the premolar to reduce any additional interferences (Mirabella et al., 2013; Thoraton, 1990).

CHAPTER 3

AIMS OF THE INVESTIGATION

3.1 Specific Aims

The aim of this study is to explore how three different groups of subjects (senior dental students, orthodontists, and laypeople) rate the esthetics of three separate orthodontic treatments. Secondly, differences in esthetic perceptions of survey takers. This will compare ratings between races and genders.

3.2 Significance

Our results may be able to offer a decision-making platform while clinicians weigh risk and benefits of the treatment outcomes for these complex cases.

CHAPTER 4

MATERIALS AND METHODS

4.1 Photograph Inclusion Criteria

Patients who have completed treatment at Temple University's Podray Orthodontics Clinic; available intraoral frontal center photograph; unilateral or bilateral canine substitution; unilateral or bilateral premolar substitution; lower incisor extraction with all spaces closed and midline centered between the center of the center incisor will be included.

These photographs have no identifying features. The photographs chosen will be "Intraoral Center" photographs, the name given for a frontal view of the dentition in maximum intercuspation. There will no identifying information in the photographs. These photographs will be taken from the Podray clinic's Dolphin Imaging software. Twelve photographs will be used (3 canine substitution, 3 premolar substitution, 3 lower incisor extractions, and 3 control images with orthodontic treatment not involving camouflages).

Participants will answer basic questions regarding age, gender and race. Twelve intraoral photographs (3 of each treatment) will be shown digitally on an iPad in random order. The same iPad will be used to ensure standardization regarding color (hue and chroma), brightness, clarity, sharpness, and photograph size. Underneath each photograph, the participant will rate the photograph esthetically on a continuous sliding scale from 1 to 10. Attempts will be made to eliminate the following variables across the photographs with photograph-enhancing software: White spot lesions, obvious dental decay, presence of facial hair, lipstick and/or other makeup, and any other blemishes.

4.2 Photograph Exclusion Criteria

Cases that are unesthetic (swollen gingiva, poor oral hygiene caries, white spot lesions), and cases that did not complete treatment (i.e., remaining spaces or early debonds) will be excluded.

4.3 Survey-Taker Inclusion Criteria

Seniors at Temple University Kornberg School of Dentistry; Orthodontists from our department and recent graduates (Convenience Sample); Laypeople who are over the age of 18 and are patients and/or guardians or parents at the clinic.

4.4 Survey-Taker Exclusion Criteria

Orthodontists who were involved in treatment of chosen cases will not partake in the survey. Laypersons under the age of 18 or those who cannot comprehend English will not partake in the survey.

4.5 Setting and Resources

The survey was designed with QuestionPro Software and was administered at Temple University Kornberg School of Dentistry. Laypeople participated in the waiting room. Fourth year dental students participated in their Cluster during lunch hour or downtime. Orthodontists participated during their lunch hour in the orthodontic clinic. All surveys were administered on the same password-encrypted iPad that only approved personnel can access.

The orthodontic department's iPad was used to administer the surveys to the patients. It is password-encrypted. All data was collected through QuestionPro. The surveys were only administered at Temple University's Department of Orthodontics in Philadelphia, Pennsylvania.

4.6 Survey Questionnaire

Using the program's iPad, QuestionPro software first required informed consent and then prompted to the survey. The survey requested the survey-taker's gender, and race. 12 individual photographs were shown chronologically. Above each photograph was the question "*Place the slider where you would rate the esthetics from 1-10*" (Miettunen, 2011). After viewing each photograph, participants moved the slider according to their own esthetic preferences on a digital continuous sliding scale from 0 (dislike) to 10 (like). The scale automatically calculated a numeric value to two decimal places (Appendix C).

4.7 Data Management and Statistical Analyses

After collection of data from the survey responses, multiple comparisons were made made, including: (1) Orthodontists' vs senior dental students' vs laypersons' esthetic preferences and (2) comparisons of any differences in preferences among gender, and ethnicity of the survey-takers. Data was assessed to be non-normally distributed, so Kruskal Wallis Tests were used for statistical analyses. Males' versus females' were compared within each category, as well as comparisons between ethnicities

CHAPTER 5

RESULTS

5.1 General Survey Information

The survey was administered between August 8st, 2023 and August 23th, 2023 to 15 orthodontists, 15 senior dental students, and 15 laypeople. The subjects included 26 females (58%) and 19 males (42%). The orthodontists surveyed were full- and part-time faculty at Temple University's Orthodontics Podray Clinic. The senior dental students were also from Temple University's Kornberg School of Dentistry. The laypeople surveyed were either patients, parents or guardians of patients and were all over the age of 18. Research consent was obtained (Appendix A).

12 images of post-treatment intraoral photographs were shown to the subjects. The subjects were instructed to place the slider where he or she would rate the esthetics from 1-10. The software automatically generated a number from 1-10 to two decimal places.

5.2 General Survey Statistics

Median scores were compared across groups using Kruskal-Wallis tests. The data was not normally distributed.

Table 1. *Lower Incisor Extraction Treatment Median Ratings*

	Orthodontist	Senior Dental Student	Layperson	Significance
Lower Incisor Image #1	7.01	3.68	4.09	P=0.151
Lower Incisor Image #2	7.19	6.78	6.53	P=0.825
Lower Incisor Image #3	7.91	7.02	7.33	P=0.553

Table 2. *Premolar Substitution Treatment Median Ratings*

	Orthodontist	Senior Dental Student	Layperson	Significance
Premolar Substitution Image #1	7.72	8.20	5.05	P=0.312
Premolar Substitution Image #2	7.51	6.98	5.16	P=0.065
Premolar Substitution Image #3	7.96	8.19	6.76	P=0.253

Table 3. *Canine Substitution Treatment Median Ratings*

	Orthodontist	Senior Dental Student	Layperson	Significance
Canine Substitution Image #1	7.21	5.80	4.18	P=0.567
Canine Substitution Image #2	6.08	6.17	5.25	P=0.520
Canine Substitution Image #3	5.51	6.38	5.99	P=0.486

Table 4. *Control Median Ratings*

	Orthodontist	Senior Dental Student	Layperson	Significance
Control Image #1	8.29	7.59	7.62	P=0.482
Control Image #2	4.93	4.50	5.65	P=0.738
Control Image #3	8.55	8.01	6.78	P=0.152

Table 5. *Subjects' Ethnicity Distribution*

Ethnicity	Number of Subjects
White	N=25
Black	N=7
East Asian	N=3
Latino	N=4
Middle Eastern	N=1
South Asian	N=5

Table 6. Median Ratings by Ethnicity

	White	Black	East Asian	Latino	Middle Eastern	South Asian	Significance
Canine Substitution Image #1	7.01	8.11	8.39	5.26	5.77	5.83	P=0.373
Canine Substitution Image #2	6.03	6.71	6.17	6.08	4.07	7.01	P=0.817
Canine Substitution Image #3	5.33	8.46	5.87	5.94	4.68	6.86	P=0.107
Premolar Substitution Image #1	8.00	8.04	8.20	7.48	8.57	6.26	P=0.411
Premolar Substitution Image #2	6.98	7.01	7.52	5.34	4.57	7.21	P=0.725
Premolar Substitution Image #3	7.93	8.98	9.13	6.22	8.34	6.78	P=0.111
Lower Incisor Image #1	6.78	4.86	5.76	7.66	3.35	6.60	P=0.540
Lower Incisor Image #2	6.67	6.93	7.17	6.30	4.60	5.09	P=0.954
Lower Incisor Image #3	7.91	7.34	9.29	6.56	6.56	6.74	P=0.869
Control Image #1	8.41	6.94	6.96	8.04	7.03	6.87	P=0.264
Control Image #2	4.93	6.11	5.67	5.20	3.56	3.73	P=0.536
Control Image #3	8.01	8.55	8.06	5.82	5.55	6.89	P=0.611

Table 7. Gender Distribution

Gender	Number of Subjects
Male	N=19
Female	N=26

Table 8. Median Ratings by Gender

	Male	Female	Significance
Canine Substitution Image #1	6.86	6.26	P=0.809
Canine Substitution Image #2	6.03	6.56	P=0.334
Canine Substitution Image #3	5.77	6.23	P=0.329
Premolar Substitution Image #1	8.05	7.72	P=0.963
Premolar Substitution Image #2	7.02	6.98	P=0.402
Premolar Substitution Image #3	7.99	7.66	P=0.428
Lower Incisor Image #1	7.1	5.59	P=0.058
Lower Incisor Image #2	7.26	5.90	P=0.069
Lower Incisor Image #3	7.93	7.12	P=0.144
Control Image #1	8.25	7.92	P=0.722
Control Image #2	5.65	4.51	P=0.198
Control Image #3	8.46	7.90	P=0.223

5.3 Survey Results

There were no significant differences across all three groups of subjects' median ratings for all four treatment types. There were no significant differences in preferences between genders and ethnicities. For all median ratings except for Canine Substitution Image (CSI) #2 and CSI #3, all male scores were higher than female scores. The treatment type with the overall highest median rating is the *Control treatment* (7.59), and the treatment type with the overall lowest median rating is the *Canine Substitution* treatment (5.99). The camouflage treatment with the overall highest median rating is the *Premolar Substitution* treatment (7.51). The image with the overall highest median rating by orthodontists is Control Image (CI) #3. The image with the overall highest median rating by senior dental students is Premolar Substitution Image (PSI) #1. The image with the overall highest median rating by laypeople is CI #1.

CHAPTER 6

DISCUSSION

6.1 General Survey Overview and Commentary

The author was the individual responsible for administering all 45 surveys. Although no additional commentary was requested within the survey itself, the author documented any commentary that was willingly offered while the subject completed the survey. The subjects were informed that any offered commentary would be documented and used supplementarily to evaluate the results.

Initially, laypeople were more hesitant to participate in the survey than the senior dental students or the orthodontists. The author found this interesting. Several laypeople were not acceptable candidates to be subjects due to their inability to read and understand English. For those laypeople that were eligible candidates (over the age of 18 and can read and understand English), the most common question was “How long will this take?” Additionally, the laypeople were 2/3 female participants. The laypeople were either patients or parents/guardians of patients who were either waiting for their own appointment, or waiting for their child. This supports other studies illustrating that females seek orthodontic treatment more than males, and that mothers accompany their children to medical appointments more than fathers (Hung et al., 2023). The consent stated that the survey would take the subject 15 minutes to complete, however, the average time required to take the survey was 5.27 minutes.

Orthodontists rated all three lower incisor images higher than the other subject groups. For two of the three canine and premolar images, senior dental students rated them higher

than the other subjects. For two of three control images, orthodontists rated them higher than the other two subjects.

During the survey administration, orthodontists' commentary acknowledged the complexity of the case. They immediately noticed a missing lower incisor, but despite a missing tooth and a non-coincident midline, they rated these images highest out of the subject groups due to the complexity of the case and the acceptable outcome. Orthodontists tended to count the teeth present in the photograph more than the senior dental students. None of the laypeople counted teeth in the image or mentioned any notice of any missing teeth. Four of the 15 surveyed orthodontists said aloud that they "know this is a 4-bicuspid extraction" when on the premolar substitution image. This illustrates that even the specialists did not notice that it was a camouflaged treatment, missing either one or both maxillary canines.

6.2 Author's Explanations for Ratings

6.2a Lower Incisor

The senior dental students overall expressed concerns over gingival margin heights, symmetry, gingival inflammation, tooth shade and shape. The lowest median rating across all images and subject groups is Lower Incisor Image (LII) #1, rated by the senior dental students. The author attributes this to the uneven and asymmetric lower incisor gingival margin at the middle lower incisor, exaggerating the noncoincident midlines.

6.2b Canine

Canine substitution image scores were relatively high in the orthodontist group. In CSI #1 and CSI #2, the patient's treatment plan included lower premolar extractions. During the survey-taking, orthodontists tended to count the teeth present more than the other

subjects. They expressed that they noted the complexity of the case and the effort it took to achieve the final result. CSI #3 was rated the lowest by the orthodontists, and did not have lower premolar extractions, and the orthodontists considered it a less complex case, maintaining the Class II molar relationship. The orthodontists also noticed a torque discrepancy on tooth #11 which is substituting for missing #10 in CSI #3. Interestingly, the patient herself noticed this and she returned for re-treatment to address it.

6.2c Premolar

Although not statistically significant, the premolar substitution treatment type had the highest ratings overall across out of the camouflage treatments. Premolar Substitution Image #3, which was the only bilateral premolar substitution in the maxillary arch was rated the highest in the orthodontist and layperson group, and only 0.01 points lower than PSI #3 in the dental student group. The author attributes this to the symmetry of the dentition, making it overall more esthetic. However, in the dental student group, PSI #1 is rated the most esthetic. Compared to PSI #3, this image has whiter teeth, less plaque and inflamed gingiva, and more triangular-shaped upper incisors. PSI #3 has more square-shaped upper incisors. Dental students tended to value ideal tooth proportions more than the other groups.

6.2d Control

CI #1 and CI #3 were the highest rated overall images in the study. Interestingly, CI #2 was the lowest rated image overall, and across all three groups. The author attributes this to the presence of white spot lesions on the upper incisors, and the inflamed posterior papillae. CI #3 has a fractured mesial-incisal edge on the upper left central incisor. The dental students rated CI #3 lower than the orthodontists and the author attributes this to the

dental students noticing a tooth that needs a restoration more than an orthodontist would have a concern.

6.2e Ethnicity

When ratings were grouped by ethnicity, the highest rated image overall was LII #3 by East Asian subjects (9.29). Out of all three Lower Incisor Extraction treatment images, both LII #2 and LII #3 were rated highest by East Asians, and LII #1 was rated highest by Latinos. Congenitally missing lower incisors are most common in Asian populations (Endo et al, 2006), and Class III malocclusions are most common in Asian and Hispanic populations (Proffit, 1998). This illustrates that Asians may be more adapted to seeing non-coincident midlines, and Asians and Hispanics may be more likely to receive Class III camouflage treatment with a lower incisor extraction (Proffit, 1998).

6.2f Gender

Overall, females tended to be more critical overall in their ratings, as all ratings except for two images were rated higher by males. Possibly the most interesting difference across gender ratings is that the only 2 images where female ratings outdid male ratings were CSI #2 and CSI #3, canine substitution. Maxillary lateral agenesis is more common in females than males (Polder et al. 2004; Endo et al., 2006). This may illustrate that the female population is more acquainted to canine substitution among their female constituents. Males also may be more critical for the opposite sex who are congenitally missing upper front teeth – the most visible at first glance.

6.3 Limitations

A limitation of the study was the use of convenience samples. The orthodontists possess various philosophies and ideologies on the idea of ideal esthetics, and what truly makes a

case more “complex” or “camouflaugeable”. The Senior Dental Students were all trained uniformly, so there was a lack of diversity in education.

Additionally, the images used were standardized to the best of the author’s ability, but it is virtually impossible to completely eliminate any distractors or confounders.

CHAPTER 7

CONCLUSION

The conclusions of this study are as follows:

- Orthodontists, senior dental students, and laypeople had no specific esthetic preferences.
- Orthodontic treatment outcomes were equivocally satisfactory for all surveyed subjects.
- Gender and ethnicity did not influence the degree of satisfaction.
- The orthodontist scores reflected their knowledge of the complexity of the case, whereas, the dental students paid attention to gingival margin heights and midlines, and color and shape of teeth.
- Straightness of teeth was preferred by the laypeople.

Orthodontic camouflage treatment outcomes were equivocally satisfactory for all surveyed orthodontists, senior dental students, and laypeople, and there were no significant differences across all subjects' median ratings. Our results may be able to offer a platform when a clinician is offering a camouflage treatment to his or her patient. It may be useful to let the patient know that an individual with extensive training in evaluating dental esthetics, and a layperson with no training, show no difference preference in esthetics across all treatment types.

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APPENDIX A

INSTITUTION REVIEW BOARD HIPAA WAIVER & APPROVAL (Protocol Number: 30435)



Research Integrity & Compliance
Student Faculty Center
3340 N. Broad Street, Suite 304
Philadelphia PA 19140

Institutional Review Board
Phone: (215) 707-3390
Fax: (215) 204-4609
e-mail: irb@temple.edu



Approval for a Project Involving Human Subjects Research that is Approved as Exempt

Date: 10-Apr-2023

Protocol Number: **30435**

PI: ORHAN TUNCAY

Review Type: EXEMPT

Approved On: 10-Apr-2023

Risk: Minimal risk

Committee: A1

Sponsor: NO EXTERNAL SPONSOR

Project Title: Orthodontists', senior dental students' and laypersons' perception of esthetics of patients treated orthodontically with maxillary canine substitution, maxillary premolar substitution and lower incisor extraction

The IRB approved the protocol 30435.

The study was approved under Exempt review. The IRB determined that the research **does not require a continuing review**, consequently there is not an IRB approval period.

As this research was approved as Exempt, the IRB will not stamp the consent or assent form(s).

Note that all applicable Institutional approvals must also be secured before study implementation. These approvals include, but are not limited to, Medical Radiation Committee ("MRC"); Radiation Safety Committee ("RSC"); Institutional Biosafety Committee ("IBC"); and Temple University Survey Coordinating Committee ("TUSCC"). Please visit these Committees' websites for further information.

Finally, in conducting this research, you are obligated to submit the following:

- **Amendments - Any changes to the research that may change the Exempt status of this study must be reviewed and approved by the IRB prior to implementation.** Examples of such changes are: including new, sensitive questions to a survey or interview, changing data collection such that de-identified data will now be identifiable, including an intervention in the methods, changing variables to be collected from medical charts, decreasing confidentiality measures, including minors or adults lacking capacity to consent as subjects when previously only adults with capacity to consent were to be enrolled, no longer collecting signed HIPAA Authorization, etc. Please reach out to the IRB Staff with any questions about if a change to the study warrants an Amendment.
- **Reportable New Information** - Using the Reportable New Information e-form, report new information items such as those described in HRP-071 Policy - Prompt Reporting Requirements to the IRB **within 5 days**.
- **Closure report** - Using a closure e-form, submit when the study is permanently closed to enrollment; all subjects have completed all protocol related interventions and interactions; collection of private identifiable information is complete; and analysis of private identifiable information is complete.

For the complete list of investigator responsibilities, please see the HRP-070 Policy – Investigator Obligations, the Investigator Manual (HRP-910), and other Policies and Procedures found on the Temple University IRB website: <https://research.temple.edu/irb-forms-standard-operating-procedures>.

Please contact the IRB at (215) 707-3390 if you have any questions.



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Approval of the waiver of HIPAA authorization

Date: 10-Apr-2023

Protocol Number: 30435

PI: ORHAN TUNCAY

Committee: A1

Project Title: Orthodontists', senior dental students' and laypersons' perception of esthetics of patients treated orthodontically with maxillary canine substitution, maxillary premolar substitution and lower incisor extraction

On 10-Apr-2023, the Temple IRB approved the waiver or alteration of HIPAA authorization for the protocol approved with submission # **30435-0003**. The waiver or alteration was reviewed and approved under expedited review procedures.

If this is an alteration of HIPAA authorization, additional information regarding the alteration will be provided below or in a separate manual letter.

The IRB has determined that all the specified criteria for a waiver of HIPAA authorization were met:

The description of the Protected Health Information (PHI), for which use or access is being requested, is included in the protocol summary or a separate data collection document and is necessary for the research.

The use or disclosure of protected health information involves no more than a minimal risk to the privacy of individuals, based on, at least, the presence of the following elements: an adequate plan to protect the identifiers from improper use and disclosure; an adequate plan to destroy the identifiers at the earliest opportunity consistent with conduct of the research, unless there is a health or research justification for retaining the identifiers or such retention is otherwise required by law; and adequate written assurances that the protected health information will not be reused or disclosed to any other person or entity, except as required by law, for authorized oversight of the research study, or for other research for which the use or disclosure of protected health information for which an authorization or opportunity to agree or object is not required by 45 CFR 164.512.

The research could not practicably be conducted without the waiver or alteration.

The research could not practicably be conducted without access to and use of the protected health information.

Please contact the IRB at (215) 707-3390 if you have any questions.

Yuri C. Pillai

Yuri C. Pillai

04/10/2023

APPENDIX B

RESEARCH SUBJECT CONSENT FORM

Title: Orthodontists', senior dental students' and laypersons' perception of esthetics of patients treated orthodontically with canine substitution, premolar substitution and lower incisor extraction

Protocol No.: 30435

Principle Investigator: Orhan C. Tuncay, DMD

Student Investigator: Amanda Noyek, DMD

Daytime Phone Number: 754-232-4455

Email: tup44593@temple.edu

RESEARCH CONSENT

You are being asked for your consent to take part in a research study. This consent document describes the key information that we believe most people need to decide whether to take part in this research.

Why am I being invited to participate in this research?

The aim of this study is to explore how three different groups of subjects (senior dental students, orthodontists, and laypeople) rate the esthetics of three separate orthodontic treatments. The secondary aims are to compare how people within these groups of different ages, race and gender rate the esthetics. Our conclusion may be expected to aid the decision-making process in orthodontic treatment.

How long will I be in this research?

We expect that your participation in this research will last 15 minutes.

What happens to me if I agree to take part in this research?

If you decide to take part in this research study, you will be asked to complete a survey. This survey will take 15 minutes and your answers to all questions are unidentifiable. By agreeing to this consent statement, you are agreeing that none of the patient records included in the survey will be copied, utilized outside the bounds of completing the survey or shown in any way.

What are the risks of this study?

There are no physical or mental risks associated with the completion of this survey study. There is a mild risk of breach of confidentiality. Your participation in this research will be held strictly confidential.

What happens to the information collected for this research?

The information that you divulge in this survey study may be shared with individuals and organizations that conduct or watch over this research, including, if applicable:

· Temple University and the research investigator's MS Thesis Committee

- The Institutional Review Board (IRB) that reviewed this research
- An abstract and summary of the research may be presented at research meetings and may culminate in publishable results

The data collected from each participant in the survey will be assigned a de-identified number and all data will be analyzed using this de-identified information.

We may publish the results of this research. However, we will keep your name and other identifying information confidential.

We will de-identify this data and share it with other researchers for research that is currently unknown.

Who can answer my questions about this research?

If you have questions, concerns, or complaints, or think this research has hurt you or made you sick, talk to the research team at the phone number or email listed above on the first page.

This research is being overseen by an Institutional Review Board (“IRB”). An IRB is a group of people who perform independent review of research studies. You may talk to them at (215) 707-3390 or irb@temple.edu if:

- You have questions, concerns, or complaints that are not being answered by the research team.
- You have questions about your rights as a research subject.

Will I be paid for taking part in this research?

There is no compensation for participation in this research.

APPENDIX C

SURVEY DESIGN

You are a:

- Orthodontist
 - Senior Dental Student
 - Patient / Parent of patient
-

What is your racial or ethnic identity? (Select all that apply.)

- African-American/Black
 - East Asian
 - Hispanic/Latinx
 - Middle Eastern
 - American Indian/Alaskan Native
 - Pacific Islander
 - South Asian
 - Southeast Asian
 - White
 - Other (please specify)
-

What is your gender?

- Female
 - Male
 - Other (specify)
-

Figure 1.
*Lower
Incisor
Image #1*

Place the slider where you would rate the esthetics from 1-10.



Rate

Rate slider: A horizontal bar with a blue slider knob positioned at the far left end, indicating a low aesthetic rating.

Figure 2.
*Premolar
Image #1*

Place the slider where you would rate the esthetics from 1-10.



Rate

Rate slider: A horizontal bar with a blue slider knob positioned at the far left end, indicating a low aesthetic rating.

Figure 3.
Control
Image #1

Place the slider where you would rate the esthetics from 1-10.



Rate

A horizontal slider bar with a blue square marker positioned at the far left end, indicating a rating of 1.

Place the slider where you would rate the esthetics from 1-10.

Figure 4.
Canine
Image #1



Rate

A horizontal slider bar with a blue square marker positioned at the far left end, indicating a rating of 1.

Figure 5.
*Lower
Incisor
Image #2*

Place the slider where you would rate the esthetics from 1-10.



Rate

A horizontal slider bar with a blue square marker positioned at the far left end, indicating a rating of 1.

Figure 6.
*Control
Image #2*

Place the slider where you would rate the esthetics from 1-10.



A horizontal slider bar with a blue square marker positioned at the far left end, indicating a rating of 1.

Figure 7.
Premolar
Image #2

Place the slider where you would rate the esthetics from 1-10.



Rate

Rate slider showing a value of approximately 10.

Place the slider where you would rate the esthetics from 1-10.

Figure 8.
Canine
Image #2



Rate

Rate slider showing a value of approximately 10.

Figure 9.
*Lower
Incisor
Image #3*

Place the slider where you would rate the esthetics from 1-10.



Rate

A horizontal slider bar with a blue square marker positioned at the far left end, indicating a rating of 1.

Figure 10.
*Premolar
Image #3*

Place the slider where you would rate the esthetics from 1-10.



Rate

A horizontal slider bar with a blue square marker positioned at the far left end, indicating a rating of 1.

Figure 11.
Control
Image #3

Place the slider where you would rate the esthetics from 1-10.



Rate

Rate slider: A horizontal slider bar with a blue square marker positioned at the far left end, indicating a rating of 1.

Figure 12.
Canine
Image #3

Place the slider where you would rate the esthetics from 1-10.



Rate

Rate slider: A horizontal slider bar with a blue square marker positioned at the far left end, indicating a rating of 1.