Original Article

Prediction of orthodontic treatment of surgically exposed unilateral maxillary impacted canine patients

Brian Smith[a]; Kelton Stewart[b]; Sean Liu[c]; George Eckert[d]; Katherine Kula[e]

ABSTRACT

Objective: To determine whether clinical variables associated with surgically exposed unilateral maxillary impacted canine cases are predictors for orthodontic treatment choices involving (1) extraction, (2) expansion, (3) extraction and expansion, or (4) nonextraction and nonexpansion.

Materials and Methods: A retrospective study of records of 97 cases meeting the inclusion criteria with unilateral maxillary impacted canines from three private practices were reviewed for gender, age, molar classification, impaction location and angulation, and presence of pretreatment maxillary and mandibular casts and cephalograms. Maxillary and mandibular transverse dimensions and lower incisor crowding were obtained from occlusal cast images using custom computer software. Skeletal analysis and incisor angulation and position were obtained from digitized cephalometric tracings. Statistical comparisons were made to determine parameters orthodontists could use to develop an orthodontic treatment plan.

Results: Subjects with Class II end-on molars on the nonaffected side were less likely to have extraction and/or expansion. Subjects with extraction and/or expansion had decreased lower incisor to mandibular plane, available canine space, maxillary premolars, and molar transverse dimensions and an increased mandibular incisor Irregularity Index compared with nonextraction/nonexpansion subjects. Using a multiple-variable model, available canine space was the single most important predictor of extraction and/or expansion, followed by maxillary molar transverse dimension and mandibular incisor Irregularity Index.

Conclusions: Available canine space, maxillary transverse dimension at the molars, and the mandibular incisor Irregularity Index serve as indicators for extraction and/or expansion in cases involving unilateral maxillary impacted canines requiring surgical exposure. Many of these cases are treated without extraction and/or expansion. (*Angle Orthod.* 2012;82:723–731.)

KEY WORDS: Impacted canines; Extraction; Expansion; Nonextraction; Nonexpansion

[a] Resident, Department of Orthodontics and Oral Facial Genetics, Indiana University School of Dentistry, IUPUI, Indianapolis, Ind.

[b] Clinical Director and Assistant Professor of Orthodontics, Department of Orthodontics and Oral Facial Genetics, Indiana University School of Dentistry, IUPUI, Indianapolis, Ind.

[c] Assistant Professor of Orthodontics and Director, Mineralized Tissues and Histology Research Lab, and Director, Orthodontic Fellowship Program, Department of Orthodontics and Oral Facial Genetics, Indiana University School of Dentistry, IUPUI, Indianapolis, Ind.

[d] Biostatistician Supervisor, Indiana University School of Medicine, Department of Biostatistics, Indianapolis, Ind.

[e] Joseph R. & Louise Ada Jarabak Endowed Professor, Chair, and MSD Program Director, Department of Orthodontics and Oral Facial Genetics, Indiana University School of Dentistry, IUPUI, Indianapolis, Ind.

Corresponding author: Dr Katherine Kula, Indiana University School of Dentistry, IUPUI, 1121 W Michigan St, Indianapolis, IN 46202

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INTRODUCTION

Maxillary impacted canines are commonly encountered in orthodontics; their frequency is well reported in the general population.[1–4] Approximately 2.5% of maxillary canines become impacted. Maxillary impacted canines are second only to maxillary third molars in frequency of dental impactions.[3,5–7] Incidence is greater in females,[5,8–10] with palatal impactions occurring twice as often in females.[9] Impactions occur in a palatal, mid-ridge, or labial position, with most becoming impacted in the palatal location.[11–13] Displaced canines cannot be palpated either buccally or palatally 85% of the time and have been shown to cause resorption of adjacent teeth.[5,14–16] Increased treatment time[17,18] and compromised esthetic results[19] are also associated with impacted maxillary canines.

A variety of causes for canine impactions are hypothesized.[20] Palatal impactions are associated with various dental anomalies, including anomalies of upper lateral incisors, aplasia, and impaction of other teeth.[21] Palatal impactions have sufficient space for eruption 85% of the time,[13] while labial impactions have inadequate arch space.[22] The genetic origin of palatally displaced canines appears to be a product of polygenic multifactorial inheritance.[23] In addition to genetic influence, environmental factors, such as peg-shaped laterals or diminutive lateral incisors, are also contributory to canine impactions.[24]

Studies examining a relationship between maxillary impacted canines and transverse discrepancies are contradictory. A premaxillary skeletal deficiency is associated with labial impactions, while maxillary transverse excess is associated with palatally impacted canines.[25] Anterior transverse deficiencies are significant in patients with canine impactions.[26] Conversely, Langberg and Peck[27] state that there is no difference in the anterior and posterior maxillary arch width of subjects with palatally displaced canines. Saiar et al.[28] show that in the evaluation of posteroanterior cephalograms, no difference is found in the width ratio of the maxilla and mandible when comparing impacted maxillary canines to Class I and Class II malocclusion controls without impactions.

The treatment of impacted canines varies depending on the clinical situation. Extraction of the primary canine frequently allows the impacted permanent canine to erupt, but the probability of eruption decreases as the canine cusp tip moves more mesially.[29] Expansion either of the arch or local area is necessary in some cases to create adequate space for the canine to erupt.[30] Some cases require surgical exposure[19] and/or extraction and expansion to facilitate eruption. The decisions concerning surgically exposed impacted canines have not been analyzed to determine what factors influence these decisions.

The literature is seemingly replete with research on maxillary impacted canines[1–32]; however, little research examines predictors for orthodontic treatment choice. This retrospective study sought to determine the relationship between the choices of orthodontic treatment of surgically exposed unilateral maxillary impacted canines and designated pretreatment variables. The clinical implications would extend to providing the orthodontist with a better understanding of the variables that influence or predict orthodontic treatment choices.

MATERIALS AND METHODS

The sample for this retrospective study came from a prior study that examined maxillary impacted canines in 207 subjects (137 females, 70 males) drawn from three private orthodontic offices. The original sample consisted of 153 unilateral maxillary impacted canine cases and 54 bilateral maxillary impacted canine cases. Complete pretreatment orthodontic records were identified for each subject. Initial inclusion criteria were (1) agreement by two independent examiners, using study models and radiographs, that the canines exhibited true ectopic impaction and (2) all canines required surgical exposure for retrieval. Patients with impacted canines that self-erupted after exfoliation or removal of the primary canines were not included.

In the initial study, pretreatment study models were evaluated to determine interarch molar relationships. Interarch molar relationship was recorded on both right and left sides as Class I (mesiobuccal cusp of the maxillary first permanent molar + or $-<1$ mm from the buccal groove of the mandibular first permanent molar), end-on Class II (mesiobuccal cusp of the maxillary first permanent molar between 1 mm anterior to the buccal groove of the mandibular first permanent molar and the embrasure between the mandibular first permanent molar and second premolar), full-step Class II (mesiobuccal cusp of the maxillary first permanent molar in or mesial to the embrasure between the mandibular first permanent molar and second premolar), or Class III (mesiobuccal cusp of the maxillary first permanent molar >1 mm distal to the central groove of the mandibular first permanent molar). Two examiners classified the 414 sides independently. Regarding interarch molar classification, 14 of 414 sides were initially disagreed on, representing a 96.62% agreement rate. Differences in classification were noted and reexamined by both examiners together. A classification was then agreed on, bringing agreement to 100%.

The location of each impacted canine was determined from the surgical report and/or the presence of an obvious canine bulge on the model and was recorded as facial, mid-ridge, or palatal. Canine angulation was measured on the pretreatment panoramic radiograph using a protractor with the center point positioned on the incisal tip of the canine and the reference axis parallel to the alveolar bone height between the first and second molars on the right and left sides. The angle of the ray from the incisal tip and the root apex to the reference axis was measured. Greater than 45° was considered a vertical impaction; 45° and less was considered a horizontal impaction (Figure 1).

High-resolution images of the casts were obtained of the 207 maxillary and mandibular study casts using a Canon 5D camera with a 100-mm f2.8 macro lens and ring flash mounted on a tripod. The images were captured on Av (aperture preferred mode) at f32, ISO 500, and evaluative metering. Image quality was set to "fine." Canon "remote capture" was used to enable

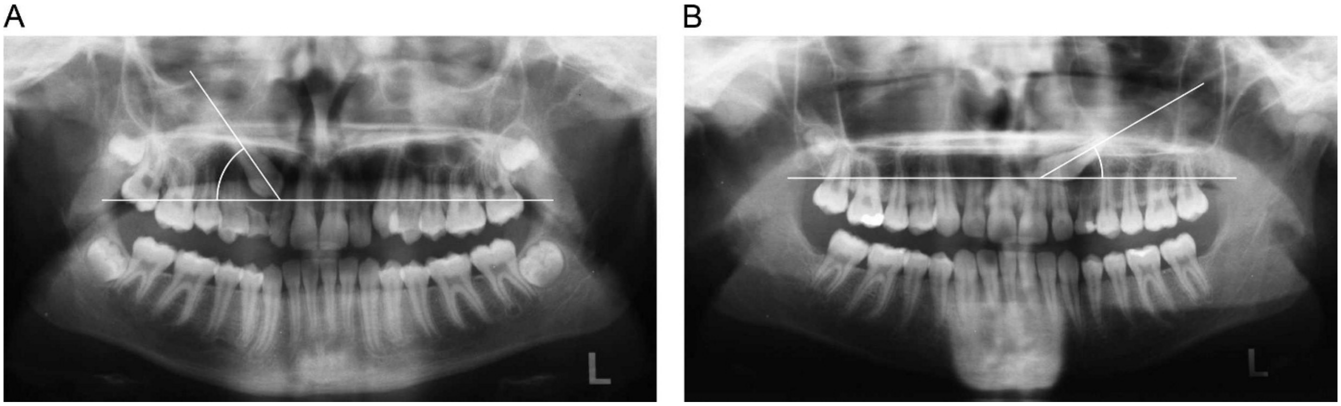

Figure 1. Examples of panoramic radiographic images with (A) vertical and (B) horizontal maxillary impacted canines.

computer screen viewing and keyboard capture of the images. A 20-mm calibration scale was placed at the occlusal plane of each image to compensate for magnification.

The inclusion criteria for this portion of the study was (1) unilateral maxillary impacted canine; (2) no prior orthodontic treatment; (3) white ethnicity only; (4) eruption of permanent maxillary and mandibular central incisors, lateral incisors, first molars, and permanent mandibular canines; (5) eruption of maxillary and mandibular first and second premolars and/or primary maxillary and mandibular first and second molars; and (6) eruption of the impacted canine after exposure. Eruption was defined as having both the mesial and distal contact points visible on the occlusal images. Instances in which a missing or unerupted tooth prevented digitization of a landmark and recording of a transverse dimension resulted in elimination of that measurement. Cusp tips constructed as part of a dental restoration resulted in exclusion of the patient's records. Of the 153 unilateral maxillary impacted canine patients, 97 patients (59 females and 38 males) aged 14.2 $\pm$ 1.9 years met the inclusion criteria.

For the purpose of this study, the following variables were evaluated: (1) gender, (2) age, (3) molar classification, (4) canine location, (5) canine position, (6) available canine space, (7) maxillary transverse dimensions, (8) mandibular transverse dimensions, (9) maxillary incisor angulation, (10) maxillary incisor position, (11) mandibular incisor angulation, (12) mandibular incisor position, (13) maxillary/mandibular skeletal relationship, and (14) lower incisor crowding.

Following calibration on the 20-mm scale, the points listed in Table 1 were digitized by one investigator (B.S.). Maxillary and mandibular anterior and posterior transverse dimensions, mandibular incisor crowding, and available space for the maxillary impacted canine were assessed using a custom J2SE Java application (Table 1; Figure 2). The digitization point for cusp tips was defined as the center of the cusp tip of interest. In instances in which occlusal wear prevented the cusp tip from being identified, the center of the wear facet was used. Incisor crowding was assessed as the summed displacement of adjacent anatomic contact points of the mandibular anterior teeth, as described by Little (Figure 3).[33]

Cephalometric radiographs coinciding with the orthodontic models were imported and traced by the same investigator (B.S.) using Dolphin Imaging, version 11.0 (Dolphin Imaging, Chatsworth, Calif; Figure 4). Maxillary and mandibular skeletal relationship, maxillary incisor inclination and position, and mandibular incisor inclination and position were determined as defined in Table 2 and Figure 4.

Actual orthodontic treatment, based on treatment notes, was classified as (1) extraction, (2) expansion, (3) extraction and expansion, and (4) nonextraction and nonexpansion and was associated with the overseeing orthodontist. Maxillary expansion was defined as expansion achieved through use of a hyrax expander.

Intraexaminer reliability was examined a priori using two measurement sessions of 10 subjects each, with coded and randomized casts and cephalograms. Reliability was also assessed during and after primary data collection, using the same 10 subjects, for a total of four reliability measurement sessions.

Statistical Analysis

Intrarater reliability was assessed for each measurement using intraclass correlation coefficients (ICCs) and Bland-Altman plots. Descriptive statistics (counts and percentages or means, standard deviations, and ranges for categorical and for continuous variables) were summarized overall and by orthodontic treatment. Each of the predictors was examined individually for relationship with the orthodontic treatment method using logistic regression, with orthodontist included as a covariate. Multiple-variable logistic regression models

Table 1. Digitized Maxillary and Mandibular Landmarks and Parameters

Landmark	Definition
Maxilla	
URPI	Maxillary right permanent first premolar buccal cusp tip or maxillary right primary first molar mesiobuccal cusp tip
ULPI	Maxillary left permanent first premolar buccal cusp tip or maxillary left primary first molar mesiobuccal cusp tip
URPII	Maxillary right permanent second premolar buccal cusp tip or maxillary right primary second molar mesiobuccal cusp tip
ULPII	Maxillary left permanent second premolar buccal cusp tip or maxillary left primary second molar mesiobuccal cusp tip
URMI	Maxillary right permanent first molar mesiobuccal cusp tip
ULMI	Maxillary left permanent first molar mesiobuccal cusp tip
URMII	Maxillary right permanent first molar central fossae
ULMII	Maxillary left permanent first molar central fossae
CSI	Impacted side maxillary permanent lateral incisor distal contact point
CSII	Impacted side maxillary permanent first premolar mesial contact point
Mandible	
LRPI	Mandibular right permanent first premolar buccal cusp tip or mandibular right primary first molar mesiobuccal cusp tip
LLPI	Mandibular left permanent first premolar buccal cusp tip or mandibular left primary first molar mesiobuccal cusp tip
LRPII	Mandibular right permanent second premolar buccal cusp tip or mandibular right primary second molar mesiobuccal cusp tip
LLPII	Mandibular left permanent second premolar buccal cusp tip or mandibular left primary second molar mesiobuccal cusp tip
LRMI	Mandibular right permanent first molar mesiobuccal cusp tip
LLMI	Mandibular left permanent first molar mesiobuccal cusp tip
LRMII	Mandibular right permanent first molar distobuccal cusp tip
LLMII	Mandibular left permanent first molar distobuccal cups tip
RCaM	Mandibular right canine mesial anatomic contact point
RLD	Mandibular right lateral incisor distal anatomic contact point
RLM	Mandibular right lateral incisor mesial anatomic contact point
RCD	Mandibular right central incisor distal anatomic contact point
RCM	Mandibular right central incisor mesial anatomic contact point
LCM	Mandibular left central incisor mesial anatomic contact point
LCD	Mandibular left central incisor distal anatomic contact point
LLM	Mandibular left lateral incisor mesial anatomic contact point
LLD	Mandibular left lateral incisor distal anatomic contact point
LCaM	Mandibular left canine mesial anatomic contact point
Parameter	
MaPWI	Interpremolar width between URPI and ULPI
MaPWII	Interpremolar width between URPII and ULPII
MaMWI	Intermolar width between URMI and ILMI
MaMWII	Intermolar width between URMII and ULMII
CS	Impacted side canine space between CSI and CSII
MdPWI	Interpremolar width between LRPI and LLPI
MdPWII	Interpremolar width between LRPII and LLPII
MdMWI	Intermolar width between LRMI and LLMI
MdMWII	Intermolar width between LRMII and LLMII
RCaM-RLD	Distance between RCaM and RLD
RLM-RCD	Distance between RLM and RCD
RCM-LCM	Distance between RCM and LCM
LCD-LLM	Distance between LCD and LLM
LLD-LCaM	Distance between LLD and LCaM

were developed using a stepwise model selection procedure. The study had 80% power to detect an odds ratio of 2.35, with the observed sample sizes of 24 patients with expansion and/or extraction and 73 patients with no expansion and no extraction. A probability of ≤.05 was considered significant.

RESULTS

All ICCs were ≥0.95, and reliability was considered excellent. Tables 3 and 4 provide descriptive statistics for the categorical and continuous variables, respectively. Approximately 75% of the subjects had no extraction and no expansion. Therefore, because of this limitation, the analyses grouped subjects with any extraction and/or expansion and compared them with subjects with no extraction or expansion.

Subjects with Class II end-on molars on the unaffected side were less likely to have extraction and/or expansion (Table 5). Subjects with extraction and/or expansion had decreased L1-MP, CS, MaPWI, MaPWII, MaMWI, and MaMWII and increased

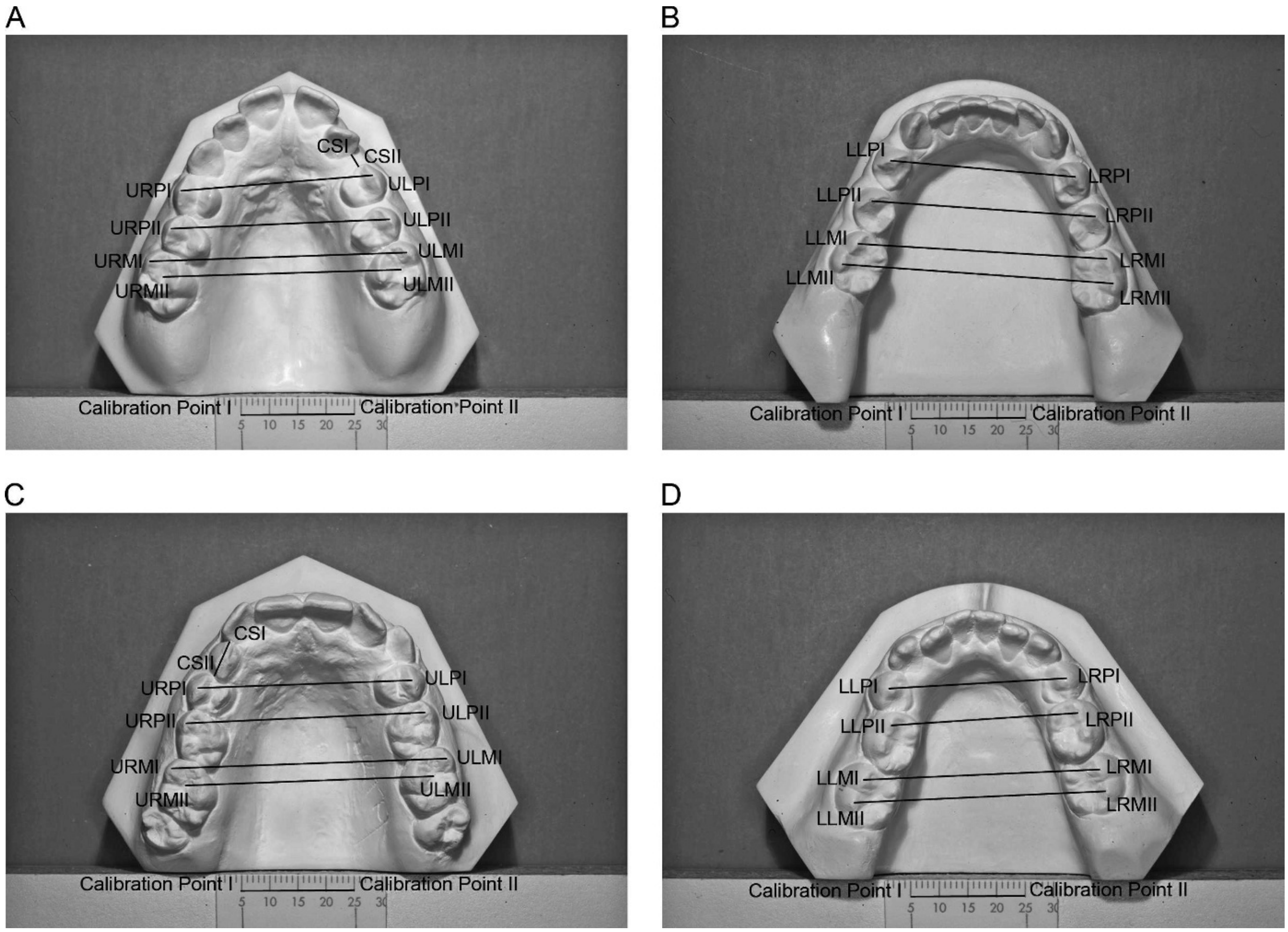

Figure 2. Examples of images with (A) maxillary measurements (permanent dentition), (B) mandibular measurements (permanent dentition), (C) maxillary measurements (primary dentition), and (D) mandibular measurements (primary dentition).

mandibular incisor Irregularity Index than nonextraction/nonexpansion subjects (Table 6).

Using a multiple-variable model, canine space was the single most important predictor of extraction and/or expansion (lower for extraction/expansion subjects), followed by maxillary molar transverse dimension (lower for extraction subjects) and mandibular incisor Irregularity Index (higher for extraction/expansion

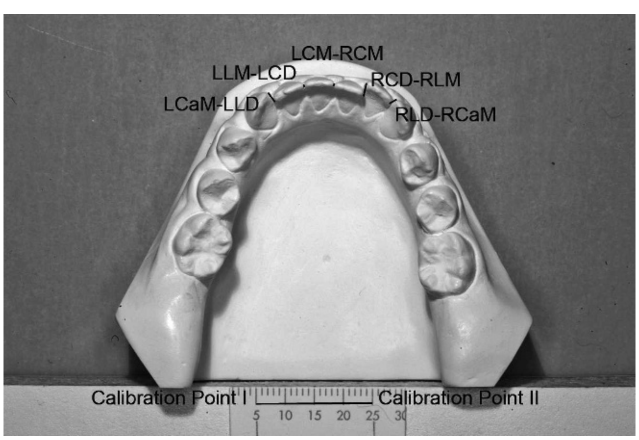

Figure 3. Mandibular incisor irregularity index.[33] Defined as the linear distances between adjacent anterior mandibular anatomic contact points.

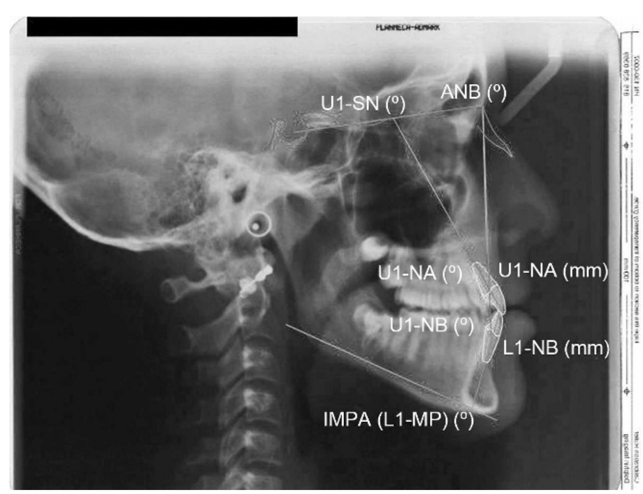

Figure 4. Example of cephalogram images with cephalometric measurements.

Table 2. Cephalometric Landmarks and Measurements

Landmark	Definition
Sella	The midpoint of the cavity of sella turcica
Nasion	The anterior point of the intersection between the nasal and frontal bones
A Point	The innermost point on the contour of the premaxilla between anterior nasal spine and the incisor tooth
B Point	The innermost point on the contour of the mandible between the incisor tooth and the bony chin
Maxillary incisor incisal tip	The most anterior and inferior point on the incisal edge of the most anterior maxillary central incisor
Maxillary incisor root apex	The most posterior and superior point on the root apex of the most anterior maxillary central incisor
Mandibular incisor incisal edge	The most anterior and superior point on the incisal edge of the most anterior mandibular central incisor
Mandibular incisor incisal apex	The most posterior and inferior point on the incisal edge of the most anterior mandibular central incisor
Menton	The most inferior point on the mandibular symphysis
Gonion	The midpoint of the contour connecting the ramus and body of the mandible
Angular measurement	
ANB	The angular difference between SNA and SNB
U1-SN	The angular inclination of the maxillary incisor relative to the SN line
U1-NA	The angular inclination of the maxillary incisor tip relative to the NA line
L1-MP	The angular difference of the mandibular incisor relative to the MP line
L1-NB	The angular inclination of the mandibular incisor relative to the NB line
Linear measurement	
U1-NA	The distance of the maxillary incisor tip relative to the NA line
L1-NB	The distance of the mandibular incisor tip relative to the NB line

subjects). The odds of extraction/expansion were decreased by 0.58 for every 1-mm increase in canine space and 0.59 for every 1-mm in maxillary molar width. Conversely, the odds of extraction/expansion increased by 1.47 for every 1-mm increase in mandibular incisor Irregularity Index.

Table 3. Descriptive Categorical Variables

Parameter	Classification	N (%)
Gender	Male	38 (39)
	Female	59 (61)
Impacted side	Right	43 (44)
	Left	54 (56)
Location	Facial	12 (12)
	Mid-ridge	6 (6)
	Palatal	79 (81)
Position	Horizontal	25 (26)
	Vertical	72 (74)
Affected side	Class I	54 (56)
	Class II end-on	30 (31)
	Class II	10 (10)
	Class III	3 (3)
Nonaffected side	Class I	54 (56)
	Class II end-on	29 (30)
	Class II	11 (11)
	Class III	3 (3)
Orthodontist	R.A.	22 (23)
	D.B.	42 (43)
	B.S.	33 (34)
Treatment	Extraction	8 (8)
	Expansion	14 (14)
	Extraction and expansion	2 (2)
	Nonextraction and nonexpansion	73 (75)
Combined treatment	Extraction and/or expansion	24 (25)
	Nonextraction and nonexpansion	73 (75)

DISCUSSION

This study agrees with others[5,8–10] that maxillary impacted canines occur more frequently in females than in males; 61% were female and 39% were males. Impactions also occurred with greater frequency in the palate (81%), agreeing with prior studies.[11–13] No difference was noted in molar classification between affected and unaffected sides. Distribution was relatively even between occurrence on either the right or left, as well as molar classification on the affected side or nonaffected sided.

A limitation of this study resulted from the relatively small number of subjects who required extraction,

Table 4. Descriptive Continuous Variables

Variable	N	Mean	SE	Min	Max
Age, years	97	14.24	0.19	11.25	21.25
ANB, °	97	2.71	0.22	−2.60	9.00
U1-SN, °	97	97.50	0.77	74.70	118.10
U1-NA, °	97	16.40	0.76	−9.60	33.40
U1−NA, mm	97	3.02	0.27	−6.20	9.00
L1−MP, °	97	88.46	0.56	77.20	101.60
L1−NB, °	97	20.16	0.55	7.60	33.70
L1−NB, mm	97	3.31	0.22	−3.20	9.30
CS, mm	97	5.43	0.23	0.09	8.76
MaPWI, mm	97	39.60	0.27	33.29	45.54
MaPWII, mm	97	44.64	0.35	36.21	51.64
MaMWI, mm	97	50.16	0.32	42.18	57.81
MaMWII, mm	97	45.85	0.28	38.74	51.96
MdPWI, mm	97	33.23	0.29	27.24	46.44
MdPWII, mm	97	38.61	0.32	29.53	52.83
MdMWI, mm	97	44.19	0.34	37.60	59.81
MdMWII, mm	97	47.30	0.36	40.98	63.69
Mandibular incisor irregularity index, mm	97	5.59	0.34	0	15.79

Table 5. Categorical Variables' *P* Values for the Comparison Between Extraction and/or Expansion and Nonextraction and Nonexpansion

		N (%)					
Parameter	Classification	Extraction	Expansion	Extraction and Expansion	Extraction and/or Expansion	Nonextraction and Nonexpansion	*P* Value
Gender	Male	1 (3)	4 (11)	1 (3)	6 (16)	32 (84)	.1193
	Female	7 (12)	10 (17)	1 (2)	18 (31)	41 (69)	
Impacted side	Right	4 (9)	4 (9)	2 (5)	10 (23)	33 (77)	.7840
	Left	4 (7)	10 (19)	0 (0)	14 (26)	40 (74)	
Location	Facial	2 (17)	1 (8)	0 (0)	3 (25)	9 (75)	.4870
	Mid-ridge	0 (0)	3 (50)	0 (0)	3 (50)	3 (50)	
	Palatal	6 (8)	10 (13)	2 (3)	18 (23)	61 (77)	
Position	Horizontal	2 (8)	5 (20)	1 (4)	8 (32)	17 (68)	.3688
	Vertical	6 (8)	9 (13)	1 (1)	16 (22)	56 (78)	
Affected side	Class I	3 (6)	9 (17)	1 (2)	13 (24)	41 (76)	.5187
	Class II end-on	2 (7)	4 (13)	1 (3)	7 (23)	23 (77)	
	Class II	3 (30)	1 (10)	0 (0)	4 (40)	6 (60)	
	Class III	0 (0)	0 (0)	0 (0)	0 (0)	3 (100)	
Nonaffected side	Class I	4 (7)	9 (17)	1 (2)	14 (26)	40 (74)	
	Class II end-on	0 (0)	3 (10)	0 (0)	3 (10)	26 (90)	**.0271***
	Class II	4 (36)	2 (18)	0 (0)	6 (55)	5 (45)	
	Class III	0 (0)	0 (0)	1 (33)	1 (33)	2 (67)	
Orthodontist	R.A.	3 (14)	0 (0)	0 (0)	3 (14)	19 (86)	.3117
	D.B.	2 (5)	9 (21)	2 (5)	13 (31)	29 (69)	
	B.S.	3 (9)	5 (15)	0 (0)	8 (24)	25 (76)	

* $P \leq .05$.

expansion, or extraction and expansion. This resulted in the comparison of extraction and/or expansion to nonextraction and nonexpansion with the continuous and categorical variables.

Orthodontic treatment was not influenced by sex, the impacted side, location, position, or orthodontist (Table 5). However, subjects with Class II end-on molars on the nonaffected side were less likely to have extraction and/or expansion. One possible explanation may be that the rotation of the molar into a Class I relationship allowed for more space to resolve crowding.

While the aim of this study was not to compare opposing arch widths to evaluate whether they play a role in impacted canines,[25–28] a constricted upper arch

Table 6. Continuous Variables' *P* Values for the Comparison Between Extraction and/or Expansion and Nonextraction and Nonexpansion

	Mean (SE)					
Variable	Extraction (n = 8)	Expansion (n = 14)	Extraction and Expansion (n = 2)	Extraction and/or Expansion (n = 24)	Nonextraction and Nonexpansion (n = 73)	*P* Value
Age, years	14.97 (1.00)	13.40 (0.31)	13.54 (1.04)	13.94 (0.40)	14.34 (0.22)	.4233
ANB, °	3.50 (0.61)	1.31 (0.41)	3.65 (1.25)	2.23 (0.39)	2.86 (0.26)	.3014
U1-SN, °	93.93 (2.23)	98.77 (2.33)	94.70 (0.30)	96.82 (1.59)	97.73 (0.89)	.6390
U1-NA, °	15.54 (2.03)	18.49 (2.12)	14.10 (0.30)	17.14 (1.42)	16.15 (0.89)	.4959
U1-NA, mm	2.64 (0.66)	3.79 (0.60)	2.35 (0.55)	3.29 (0.43)	2.93 (0.33)	.4898
L1-MP, °	87.56 (2.12)	85.11 (1.32)	89.70 (2.90)	86.31 (1.08)	89.16 (0.64)	**.0342***
L1-NB, °	17.98 (1.47)	18.36 (0.90)	26.25 (0.65)	18.89 (0.84)	20.58 (0.67)	.2069
L1-NB, mm	2.21 (0.49)	3.04 (0.40)	5.95 (1.05)	3.00 (0.35)	3.40 (0.26)	.5056
CS, mm	3.84 (0.83)	3.28 (0.63)	2.57 (1.48)	3.41 (0.47)	6.10 (0.22)	**<.0001***
MaPWI, mm	37.90 (1.14)	37.34 (0.60)	36.78 (0.23)	37.48 (0.50)	40.29 (0.28)	**.0001***
MaPWII, mm	42.55 (1.01)	41.69 (0.95)	40.48 (2.39)	41.88 (0.66)	45.55 (0.35)	**.0001***
MaMWI, mm	48.53 (0.78)	48.27 (0.92)	45.38 (1.53)	48.12 (0.62)	50.83 (0.33)	**.0004***
MaMWII, mm	43.95 (0.54)	44.30 (0.83)	40.42 (1.61)	43.86 (0.56)	46.50 (0.29)	**.0002***
MdPWI, mm	33.13 (1.42)	32.87 (0.74)	33.15 (1.49)	32.98 (0.63)	33.32 (0.33)	.5942
MdPWII, mm	37.97 (1.33)	37.97 (1.10)	39.52 (3.18)	38.10 (0.79)	38.78 (0.34)	.3232
MdMWI, mm	43.74 (1.53)	43.88 (0.97)	44.34 (1.99)	43.88 (0.75)	44.29 (0.39)	.4832
MdMWII, mm	47.21 (1.78)	47.13 (0.96)	47.31 (2.54)	47.17 (0.80)	47.34 (0.40)	.7434
Mandibular incisor irregularity index, mm	8.58 (1.33)	7.66 (0.96)	13.73 (0.60)	8.47 (0.78)	4.64 (0.30)	**<.0001***

* $P \leq .05$.

was significant when looking at extraction and/or expansion treatment. Contrary to our study, available canine space is not reported as an issue in palatal impactions.[13] However, in certain instances, space may need to be gained through extraction and/or expansion when treating patients with unilateral maxillary impacted canines with decreased lower incisor to mandibular plane (L1-MP), available canine space, constricted maxillary premolars, and molar transverse dimensions and increased mandibular incisor Irregularity Index (Table 6).

Evaluation for predictors that might influence an orthodontist's decision to extract and/or expand was determined using a multivariable model. The outcome of treatment was not predicted, only the variables that influenced the choice of treatment. Canine space was the most important factor followed by maxillary molar transverse dimension and the mandibular incisor Irregularity Index. Every 1-mm increase in canine space and maxillary molar transverse dimension (MaMWII) decreased the odds of extraction and/or expansion (or increased the odds of nonextraction and nonexpansion). Every 1-mm increase in the mandibular incisor Irregularity Index increased the odds of extraction and/or expansion (or decreased the odds of nonextraction and nonexpansion). It should be noted that because of the relatively small number of subjects treated with extraction and/or expansion, a sample containing a larger number with this method of treatment should confirm this finding. However, the power of the sample size used in this study was adequate as defined.

CONCLUSIONS

- Available canine space, maxillary transverse dimension at the molars, and mandibular incisor Irregularity Index serve as indicators for extraction and/or expansion in patients involving unilateral maxillary impacted canines requiring surgical exposure.
- The results also suggest many of these patients are treated without extraction and/or expansion.

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