Applied Medical Informatics
Original Research Vol. 44, No. 3/2022, pp: 100-111

Evaluation of Cause, Severity, Complications, and Treatment of Maxillary Canine Impaction: Dental Specialists' Perspectives

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Received: September 5, 2022/Accepted: September 14, 2022/ Published online: (September 25, 2022)

Abstract
Aim: The purpose of this study was to evaluate dental specialists' perspectives on the causes, severity, treatments, and complications of maxillary canine impaction. *Methods:* A non validated questionnaire was designed and used to gather information from orthodontists, prosthodontists, surgeons, and general dentists, between June and July 2022. The survey was posted online and advertised on the official website of Cluj Dentists' College. Practitioner's experience with tooth impaction, the cause of the impaction, the type of radiographic investigation, treatment options, and a rating of the degree of treatment difficulty and complications using panoramic radiography and cone-beam computed tomography (CBCT) were collected. *Results:* One hundred and nine dentists participated. In their practice, the maxillary canine was the most frequently encountered impacted tooth (85.32%); the most frequent etiology of impaction was lack of space (95.4%). The difficulty of a case of maxillary canine impaction on CBCT was considered lower by surgeons vs. general dentists (-30.52, 95% CI (-60.31 to -0.74), p=0.047), in case of distance from canine cusp tip to the occlusal plane is considered in interceptive treatment (25.56, 95% CI (2.09 to 49.02), p=0.035), and decreased in case of deciduous canine extraction is considered to aid treatment (-27.15, 95%CI (-51.38 to -2.93), p=0.03). *Conclusions:* Differences between specialists' level of knowledge was observed, the orthodontists being followed by general dentists, surgeons, and prosthodontists. The difficulty of a case was rated higher on CBCT than on panoramic radiography. The difficulty of a case was perceived to be lower by surgeons compared to general dentists.

Keywords: Canine impaction; Panoramic radiography; Cone-beam computed tomography (CBCT); Surveys

Introduction

Maxillary canine impactions are frequently noticed, with incidence reported in the literature of 1.7% in the general population of Irland [1], 1.9% in Saudi Arabia [2], and 3.77% of a tertiary hospital in Nepal [3]. Impacted teeth have multiple causes [4], including odontomas or lateral incisor

anomalies [5] or premature loss of deciduous teeth [6]. The maxillary canines, upon the third molars, are the second most likely tooth types to show impaction [7]. Cone-beam computed tomography (CBCT) has been shown to be more effective at establishing the location of the impacted maxillary canine than panoramic radiography [8]. Impacted maxillary canines are associated with root resorptions on neighboring teeth [9], root dilaceration [10], and canine ankylosis [11]. Different linear and angular indicators can be used on radiographic images to predict canine impaction [12]. Based on the location of the canine and the face development, a number of different prognosis approaches for maxillary canine impaction have been developed. According to the location of the canine and the face developmental tendency, a variety of different approaches have been presented for predicting maxillary canine impaction, which were developed utilizing structural assessments and computer simulations depending on diagnostic and radiographic information, in the mixed dentition, when primary and permanent teeth coexist in the oral cavity [13].

In determining which radiographic aspects influenced the orthodontists' choice of treatment decision, impacted canine buccal-palatal crown position, angulation to the midline, overlap with the adjacent incisor, and presence of neighboring incisor root resorption were described [14]. For palatal impacted canines, as interceptive treatment, maxillary palatal expansion has been proposed [15]. The classic impaction treatment consists of surgical exposure and orthodontic traction, which in some complicated situations may need adjunctive surgical techniques, such as auto-transplantation and apicectomy [16]. Treatment outcome depends on the canine position, angulation, and root development [17]. The appropriate surgical intervention for a good periodontal prognosis is still under debate [18].

The objectives of this paper were: to assess dental specialists' knowledge of the cause, severity, treatment, and complications of maxillary canine impaction; to inspect how specialty and years of practice influence their decision-making; to identify factors that influence the difficulty assessment of a clinical case of maxillary canine impaction. Dental professionals will benefit significantly from the information obtained from this observational study when evaluating maxillary canine impaction radiographic data.

Material and Method

Study Design and Setting

An observational, cross-sectional study was conducted. A non validated questionnaire was developed. One author, with over 15 years of experience in the domain drafted the questionnaire, around the clinical issues regarding canine impaction. The content was further discussed with the colleagues, and a final version was then resoluted. The questionnaire comprised twenty-five questions and was delivered for completion to dental practitioners. The study was carried out at Cluj-Napoca, Romania's the Iuliu Haţieganu University of Medicine and Pharmacy's Faculty of Dental Medicine, between June and July 2022. The survey was self-administered and voluntary, and responses were confidential. The survey was made available online using Google forms, being advertised on the official webpage of the Cluj Dentists' College and the official Facebook page of the Prosthodontic Department. Furthermore, a snowball sampling was pursued by contacting colleagues.

Participants

The inclusion criteria were dental practitioners willing to participate. Students, people in other professions, or who did not complete the questionnaire for ethical reasons, even though it was anonymous, incomplete data entry, were the exclusion criteria.

Variables

The first section of the questionnaire attempted to collect demographic information, as well as whether or not respondents had ever treated patients with dental impaction. Participants were asked if they had ever treated impaction, which tooth was the most impacted, and what the most frequent

cause for impaction was. The following section of the questionnaire focused on maxillary canine impaction. It asked participants about the type of radiographic investigation they would conduct in an impaction case, whether one radiographic investigation would be enough, how often they performed radiographic monitoring, and for how long. It also asked participants about the complications that can arise from untreated maxillary canine impaction and the various treatment options available. It inquired about factors pertaining to the early management of maxillary canine impaction and whether the treatment planning would benefit from deciduous canine extraction. The final step consisted in a clinical case from the personal archive, with a left maxillary canine impaction. The case was chosen to be a difficult one in order to highlight the decision-making process in diagnosis and treatment planning. Furthermore, the case required the availability of both panoramic radiography and CBCT. A panoramic radiography and a CBCT image were presented for the responders to assess the difficulty of the case, without informing the participants that they were recorded on the same patient. (Figure 1), The case difficulty was graded on a scale from 1 to 5, with 1 denoting the easiest and 5 the most challenging treatment approach. Demographic data (age, gender, work's place of residence, dentistry specialization, experience, in years of practice) were collected too.

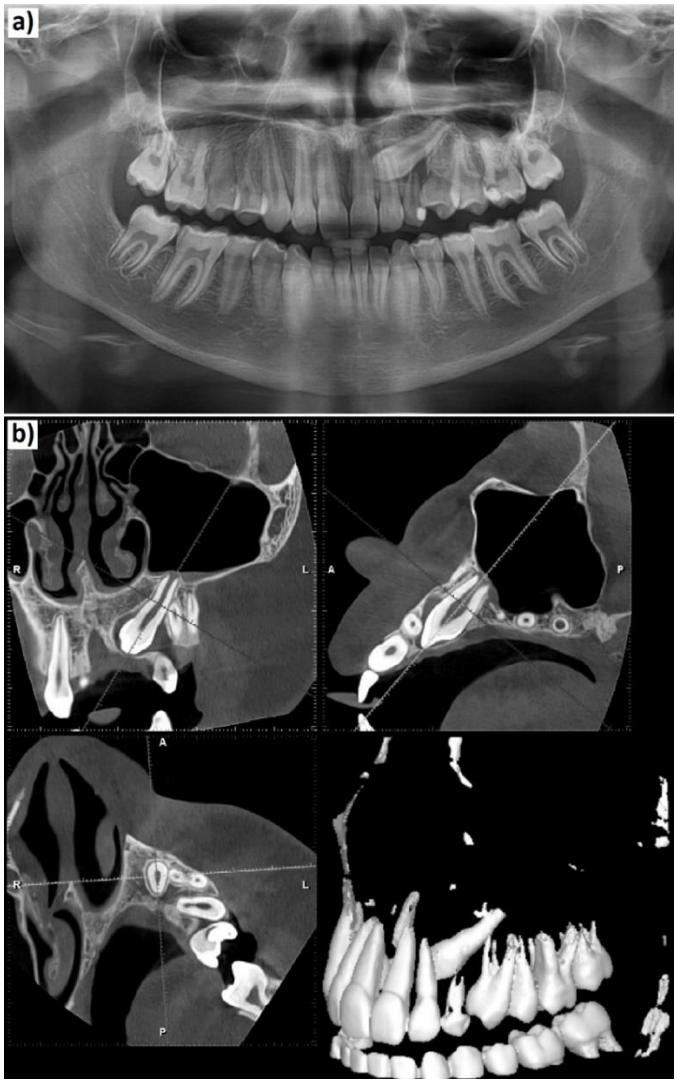

Figure 1. **a)** Panoramic radiography and **b)** Cone-beam computed tomography (CBCT) used in rating the degree of impaction difficulty; R, right; L, left; A, anterior; P, posterior.

To complete the survey, the participants ought to answer all items.

Statistical Methods

Statistical analysis was performed using R environment for statistical computing and graphics (R Foundation for Statistical Computing, Vienna, Austria), version 4.1.2. Qualitative data were presented as absolute and relative frequencies. Continuous data not following the normal distribution were presented as median and 25 and 75 percentiles. Associations between categorical variables were verified with the Chi-squared test or Fisher exact test (when the expected frequencies were <5). Comparisons between the difficulty of the case evaluated on CBCT or panoramic radiography were performed with Wilcoxon signed-rank test. To check independent predictors of the difficulty of the case, we built simple followed by multiple linear regression models, with CBCT or panoramic radiography difficulty as dependent variables, and the following explanatory variables: experience (below 5, 5-10, above 10 years), specialty (general dentistry, orthodontics, prosthodontics, surgery), patient age, lateral incisor crown overlap, distance from canine cusp tip to the occlusal plane, canine tip towards the midline, apex position, deciduous canine extraction. The variables were selected before observing the data, based solely on clinical reasoning, to identify how the experience and specialty would influence the perceived case difficulty, while controlling for clinical variables known from the clinical experience that influence the difficulty of the case. The number of independent variables was selected before the multivariate regression, by dividing the number of respondents to ten, so that there will be at least ten subjects per degree of freedom (variables including dummy variables) to prevent important overfitting. The multivariate analysis was pursued to diminish confounding bias. We performed model diagnostics on the multivariate models. We assessed the normality of the residuals with quantile-quantile plots. Since the normality assumption was violated, we performed a Box-Cox transformation on the dependent variable conditional on the explanatory variables. The homoskedasticity assumption was checked with the Breusch Pagan test, and since it did not hold, we used robust sandwich estimators. The multicollinearity assumption was verified with variance inflation factors. Furthermore, outliers and leverage points' presence were checked with Cook's D distance and studentized residuals. The variable coefficients, confidence intervals, and p-values for each regression were presented. The effect plot presented selected variables that were independent predictors of the difficulty of the case, adjusted for all the variables in the multivariable model. For all statistical tests, the two-tailed p-value was reported, and a significance level of 0.05 was used.

Results

A total number of 109 dental practitioners, with a median age of 39 years, (quartiles: 32 - 44, range: 26-57 years); 70 females (64.2%) and 39 males (35.8%); 106 working in urban areas (97.2%) and 3 (2.9%) in rural areas participated. Among them, 21 (19.3%) were surgeons, 12 (11%) orthodontists, 14 (12.8%) prosthodontists, and 62 (56.9%) general dentists.

Dental Practitioners Reported Experience with Maxillary Canine Impaction

The most encountered impacted tooth in their practice was the maxillary canine, in 93 participants (85.32%), and the lower third molar, indicated by 16 surveyors (14.67%) (Table 1). The etiology of impaction was considered as lack of space by 104 specialists (95.4%), cysts or ankylosis by 2 specialists (1.8%), supernumerary teeth, by 2 specialists (1.8%), or syndromic, 1 respondent (0.9%). As an imaging technique of choice for impaction detection, CBCT was declared by 96 participants (88.1%), whereas panoramic radiography by 13 specialists (11.9%). Only 10 (9.2%) of the specialists would indicate just one radiographic examination, whilst 99 (90.8%) would ask for second radiographic imaging. Among complications cysts (n=41), root resorption (n=106), and other complications, such as tooth migration, infection, spacing, occlusal trauma, bone resorption, occlusal dysfunction, abscess, and periodontal problems of neighboring teeth were described. As treatment modalities, interceptive treatment (n=30), surgical orthodontic treatment, (n=108) or tooth extraction (n=20) were considered.

The Influence of Specialty and Years of Practice

The orthodontists were the most knowledgeable and considered that all listed interceptive factors for canine impaction must be accounted for, while other specialties failed to identify the factors as important ($p<0.05$). The general dentists were close to orthodontists. The least informed specialists were prosthodontists.

Root resorption was reported as a complication by all specialties.

Cysts were reported more frequently by specialists with below five years of experience ($p< 0.001$). The interceptive treatment and tooth extraction were most frequently reported as possible treatment options by younger specialists compared to older specialists ($p<0.05$).

Table 1. a) Dental practitioners reported experience with maxillary canine impaction according to specialty.

	General dentistry (n=62)	Orthodontics (n=12)	Prosthodontics (n=14)	Surgery (n=21)	p-value
The most frequent impacted tooth					
Impacted tooth (maxillary canine), n (%)	57 (91.94)	12 (100)	13 (92.86)	11 (52.38)	< 0.001
Factors that account for interceptive treatment					
Patient's age, m (sd)	38 (61.29)	12 (100)	13 (92.86)	16 (76.19)	0.006
Apex position, n (%)	26 (41.94)	11 (91.67)	7 (50)	9 (42.86)	0.016
Canine tip towards the midline, n (%)	49 (79.03)	12 (100)	6 (42.86)	14 (66.67)	0.004
Lateral incisor crown overlap, n (%)	53 (85.48)	12 (100)	7 (50)	10 (47.62)	< 0.001
Distance from canine cusp tip to the occlusal plane, n (%)	52 (83.87)	11 (91.67)	7 (50)	12 (57.14)	0.006
Distance to the midline, n (%)	59 (95.16)	12 (100)	12 (85.71)	18 (85.71)	0.219
Complications					
Cysts, n (%)	16 (25.81)	5 (41.67)	6 (42.86)	14 (66.67)	0.009
Root resorption, n (%)	59 (95.16)	12 (100)	14 (100)	21 (100)	0.811
Other complications, n (%)	4 (6.45)	1 (8.33)	1 (7.14)	2 (9.52)	0.94
Deciduous canine extraction, n (%)	9 (14.52)	2 (16.67)	9 (64.29)	14 (66.67)	< 0.001
One radiography, n (%)	1 (1.61)	0 (0)	2 (14.29)	7 (33.33)	< 0.001
Type of investigation					
Paraclinical investigation (panoramic radiography), n (%)	10 (16.13)	0 (0)	1 (7.14)	2 (9.52)	0.536
Treatment					
No treatment, n (%)	1 (1.61)	1 (8.33)	1 (7.14)	3 (14.29)	0.08
Interceptive treatment, n (%)	9 (14.52)	4 (33.33)	5 (35.71)	12 (57.14)	0.001
Surgical orthodontic treatment, n (%)	62 (100)	11 (91.67)	14 (100)	21 (100)	0.11
Surgical treatment, n (%)	0 (0)	1 (8.33)	1 (7.14)	4 (19.05)	0.005
Tooth extraction, n (%)	1 (1.61)	3 (25)	8 (57.14)	8 (38.1)	< 0.001

m = arithmetic mean; sd = standard deviation

Table 1. b) Dental practitioners reported experience with maxillary canine impaction according to the years of practice.

	Years of practice			
	below 5 years (n=27)	5-10 years (n=8)	above 10 years (n=74)	p-value
The most frequent impacted tooth				
Impacted tooth (maxillary canine), nr (%)	20 (74.07)	8 (100)	65 (87.84)	0.122
Factors that account for interceptive treatment				
Patient's age, m (sd)	19 (70.37)	4 (50)	56 (75.68)	0.291
Apex position, n (%)	13 (48.15)	1 (12.5)	39 (52.7)	0.111
Canine tip towards the midline, n (%)	18 (66.67)	7 (87.5)	56 (75.68)	0.443
Lateral incisor crown overlap, n (%)	13 (48.15)	8 (100)	61 (82.43)	< 0.001
Distance from canine cusp tip to the occlusal plane, n (%)	18 (66.67)	7 (87.5)	57 (77.03)	0.399
Distance to the midline, n (%)	23 (85.19)	8 (100)	70 (94.59)	0.282
Complications				
Cysts, n (%)	21 (77.78)	3 (37.5)	17 (22.97)	< 0.001
Root resorption, n (%)	27 (100)	8 (100)	71 (95.95)	0.653
Other complications, n (%)	5 (18.52)	1 (12.5)	2 (2.7)	0.024
Deciduous canine extraction, n (%)	20 (74.07)	1 (12.5)	13 (17.57)	< 0.001
One radiography, n (%)	6 (22.22)	0 (0)	4 (5.41)	0.042
Type of investigation				
Paraclinical investigation (panoramic radiography), n (%)	2 (7.41)	2 (25)	9 (12.16)	0.322
Treatment				
No treatment, n (%)	3 (11.11)	0 (0)	3 (4.05)	0.463
Interceptive treatment, n (%)	14 (51.85)	3 (37.5)	13 (17.57)	0.002
Surgical orthodontic treatment, n (%)	27 (100)	8 (100)	73 (98.65)	1
Surgical treatment, n (%)	4 (14.81)	0 (0)	2 (2.7)	0.069
Tooth extraction, n (%)	11 (40.74)	2 (25)	7 (9.46)	0.001

m = arithmetic mean; sd = standard deviation

Case Difficulty Assessment on Panoramic Radiography and CBCT and Factors Influencing It

We observed that the difficulty score on the CBCT (median = 5, IQR [4 to 5]) case was statistically significantly higher than those on the panoramic radiography (median = 4, IQR [4 to 5]) case by a median of 1 point (p=0.001).

The predictors of the difficulty of the case using univariate and multivariate linear regression models built for the panoramic radiography image and CBCT image are presented in Table 2 a) and b). In univariate analyses, higher experience, lateral incisor crown overlap, and distance from canine cusp tip to occlusal plane significantly increased the difficulty of the case score in both presented images (panoramic radiography and CBCT). While being a prosthodontist or surgeon vs. having a general dentistry specialty and deciduous canine extraction significantly decreased the difficulty of the case score in both images. In the multivariate models including experience, specialty, patient age, lateral incisor crown overlap, distance from canine cusp tip to the occlusal plane, canine tip towards the midline, apex position, deciduous canine extraction, the distance from canine cusp tip to the occlusal plane, and deciduous canine extraction remained statistically significant, in both images, while surgical specialty was statistically significant in the CBCT image, and close to statistical significance in the panoramic radiography image. The effect of the specialty adjusted for all the variables in the full model on the difficulty of the CBCT image is presented in Figure 2. The full model predicting the difficulty in the panoramic radiography image was statistically significant ($p < 0.001$), with an adjusted coefficient of determination of 0.38. The full model predicting the difficulty in the CBCT image was statistically significant ($p < 0.001$), with an adjusted coefficient of determination of 0.37.

Table 2. a) Univariate linear regression predicting the difficulty on panoramic radiography and cone-beam computed tomography using robust sandwich estimators.

Characteristics	B unadjusted	[95% CI]	P-value
Regression assessing difficulty on panoramic radiography			
Experience (years) (5-10 vs. below 5)	1.42	[-8.05 to 10.89]	0.769
Experience (years) (above 10 vs. below 5)	13.38	[8.39 to 18.37]	< 0.001
Specialty (Orthodontics vs. General dentistry)	1.15	[-7.23 to 9.54]	0.788
Specialty (Prosthodontics vs. General dentistry)	-9.1	[-15.79 to -2.41]	0.009
Speciality (Surgery vs. General dentistry)	-16.03	[-21.25 to -10.81]	< 0.001
Patient age	0.29	[-4.64 to 5.23]	0.907
Lateral incisor crown overlap	8.19	[3.06 to 13.32]	0.002
Distance from canine cusp tip to occlusal plane	10.89	[5.98 to 15.8]	< 0.001
Canine tip towards midline	4.89	[-0.37 to 10.15]	0.071
Apex position	4.37	[-0.53 to 9.27]	0.083
Deciduous canine extraction	-14.07	[-19.15 to -9]	< 0.001
Regression assessing difficulty on cone-beam computed tomography			
Experience (years) (5-10 vs. below 5)	6.24	[-26.94 to 39.42]	0.713
Experience (years) (above 10 vs. below 5)	51.84	[33.08 to 70.6]	< 0.001
Speciality (Orthodontics vs. General dentistry)	6.67	[-24.36 to 37.69]	0.675
Speciality (Prosthodontics vs. General dentistry)	-35.83	[-61.91 to -9.76]	0.008
Speciality (Surgery vs. General dentistry)	-61.02	[-80.06 to -41.98]	< 0.001
Patient age	3.08	[-16.34 to 22.51]	0.756
Lateral incisor crown overlap	32.84	[13.09 to 52.59]	0.001
Distance from canine cusp tip to occlusal plane	42.84	[24.46 to 61.21]	< 0.001
Canine tip towards midline	20.05	[-0.21 to 40.3]	0.055
Apex position	18.22	[-0.66 to 37.1]	0.061
Deciduous canine extraction	-52.31	[-71.41 to -33.21]	< 0.001

B, independent variable coefficient; CI, confidence interval.

Table 2. b) Multivariate linear regression … (see Table 2. a).

Characteristics	B adjusted	[95% CI]	p
Difficulty on panoramic radiography			
Experience (years) (5-10 vs. below 5)	-8.87	[-20.35 to 2.6]	0.133
Experience (years) (above 10 vs. below 5)	4.08	[-3.26 to 11.43]	0.278
Specialty (Orthodontics vs. General dentistry)	0.01	[-6.44 to 6.45]	0.998
Specialty (Prosthodontics vs. General dentistry)	-1.83	[-10.17 to 6.52]	0.669
Speciality (Surgery vs. General dentistry)	-7.83	[-15.69 to 0.02]	0.054
Patient age	-0.67	[-5.73 to 4.38]	0.794
Lateral incisor crown overlap	2.34	[-3.36 to 8.03]	0.424
Distance from canine cusp tip to occlusal plane	6.49	[0.32 to 12.66]	0.042
Canine tip towards midline	-1.55	[-7.34 to 4.23]	0.6
Apex position	0.99	[-3.44 to 5.42]	0.663
Deciduous canine extraction	-8.02	[-14.46 to -1.57]	0.017
Difficulty on cone-beam computed tomography			
Experience (years) (5-10 vs. below 5)	-31.52	[-72.85 to 9.81]	0.138
Experience (years) (above 10 vs. below 5)	17.14	[-10.96 to 45.24]	0.235
Speciality (Orthodontics vs. General dentistry)	0.32	[-24.81 to 25.45]	0.98
Speciality (Prosthodontics vs. General dentistry)	-8.87	[-41.2 to 23.45]	0.592
Speciality (Surgery vs. General dentistry)	-30.52	[-60.31 to -0.74]	0.047
Patient age	-0.5	[-20.47 to 19.47]	0.961
Lateral incisor crown overlap	9.21	[-12.88 to 31.29]	0.416
Distance from canine cusp tip to occlusal plane	25.56	[2.09 to 49.02]	0.035
Canine tip towards midline	-4.6	[-26.68 to 17.48]	0.684
Apex position	4.92	[-12.34 to 22.17]	0.578
Deciduous canine extraction	-27.15	[-51.38 to -2.93]	0.03

B, independent variable coefficient; CI, confidence interval; the multivariable model includes all the variables in the table; the multivariable model includes all the variables in the table; the dependent variable in the multivariate model - the difficulty of the case was transformed to improve the normality of the residuals.

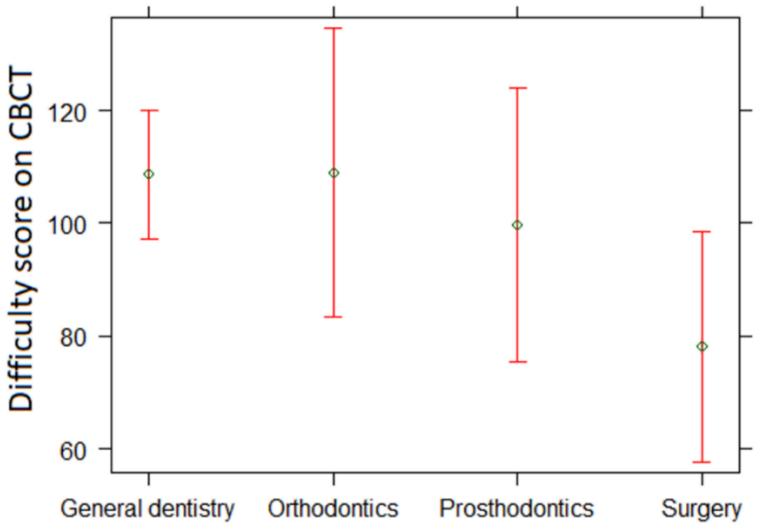

Figure 2. Effect plot of the influence of the specialty on the difficulty of the case presented on CBCT (cone beam computed tomography) – after normality of residuals Box-Cox transformation, adjusted for all the variables in the multivariable model.

Discussion

We successfully assessed dental specialists' opinions on the cause, severity, complications, and treatment of maxillary canine impaction using an online questionnaire, based on participants' specialty and years of practice, as well as assessing the difficulty of a case on panoramic radiography and CBCT sections of the same patient. The professionals' understanding of maxillary canine impaction (diagnosis, management, preferred therapy, consequences) was acceptable. Orthodontists, general dentists, surgeons, and prosthodontists were the experts with the greatest degree of competence. Orthodontists were the experts with the highest degree of knowledge, followed by general dentists, surgeons, and prosthodontists. Compared to the more experienced doctors, the younger specialists had more knowledge. On CBCT, cases were regarded as being more challenging than on panoramic radiography. Comparatively to general dentists, surgeons felt that the examined case was less complex. The difficulty of a case was rated as being more challenging when specific treatment choices were known

Pico et al. [19] studied the impaction of maxillary canines on panoramic radiography compared to CBCT images and found different information about tooth position and root resorption from the analyses of panoramic images compared to CBCT image reconstructions. We also found different opinions of the specialists regarding panoramic radiography and CBCT, expressed in the overall difficulty rating. The most frequently impacted tooth, in the opinion of general dentists, orthodontists, prosthodontists, and surgeons, was the maxillary canine.

Our results are in concordance with those of Tsolakis et al. [20], who showed that in comparison to conventional radiography, CBCT is a more accurate and precise examination technique for locating tooth impaction and detecting root resorption of the neighboring teeth. In our study, root resorption, along with cysts, were rated as possible complications of impaction, also by other specialties, as well as according to the respondent's experience. CBCT was considered the imagistic diagnosis choice, allowing better visualization of the impaction that could have implications for future treatment plan decisions. The effectiveness of the CBCT imaging modality over traditional imaging techniques in localizing impacted canines has been demonstrated in previous studies [21, 22]. One radiographic examination was considered not enough by all dental professionals and also, according to their experience. Moreover, specialists considered CBCT superior to panoramic radiography in maxillary canine impaction evaluation.

In a study evaluating the relationship between impacted maxillary canine and the neighboring lateral incisor, it has been shown that predictors of maxillary canine impaction included the lateral incisor dimensions and angulation to the midline, as well as the canine' inclination [23]. In our study, participant age, apex location, canine tip orientation to median, length between canine cuspid point to occlusion line, and overlaying with lateral incisor crown have all been taken into consideration while deciding whether or not to use interceptive therapy for the impaction.

Regarding impaction treatment, surgical exposure, followed by orthodontic traction, was considered the treatment of choice by all dental practitioners irrespective of their experience. Interceptive treatment measures and surgical treatment and tooth extraction were considered suitable. Park et al. [24] outlined two strategies for handling impacted maxillary canines: interceptive, by removal of the deciduous canine, and corrective, comprising surgical-orthodontic management.

The Influence of Specialty and Years of Practice

As expected, the best informed on maxillary canine impaction were the orthodontists.

We found that younger specialists reported more often correct treatment options (interceptive treatment) and complications than older specialists. This might suggest the need for older generations, and specialties other than orthodontics to be kept up to date with useful information about canine impaction. Continuous medical education policies should be updated based on research results similar to our study, to address the gaps in knowledge on a need base.

The degree of information held by various generations may be one explanation for the disparity in opinions between age groups. It's important to remember that the way we handle canine impaction has changed. The treatment plan went through significant adjustment for a while. In the past, making decisions was mostly based on knowledge, technical capability, and readily available tools. Modern dentistry has moved toward digital dentistry as a result of technological advancement. As a result, the great majority of products and accessories on the market now facilitate the multidisciplinary treatment of canine impaction. As a result, extraction techniques are largely ignored. By itself, canine impaction is an orthodontic issue. The impacted canine on the arch must thus be leveled and aligned, which is a challenge for orthodontists. On the other side, surgeons could alternatively choose extraction therapy followed by implant placement. For a missing canine, prosthodontics may choose to use a prosthesis. Thus, there are different approaches and treatment philosophies of various specialties.

Case Difficulty Assessment on Panoramic Radiography and CBCT and Factors Influencing It

Counihan et al. [1] described prognostic outcomes of maxillary canine impaction, considering vertical canine height, angulation to the midline, canine overlap with adjacent incisor, and canine root apex position [1] and offered perspectives on outcome and treatment according to those factors. In our study, higher practitioner's experience, univariate analyses including two very different pictures (panoramic radiography and CBCT) revealed that overlapping lateral incisor crowns and the proximity among the canine incisal edge and the dentition plane considerably enhanced the dilemma of the case rating, while deciduous canine removal, prosthetic treatment, or surgery as compared to general dentistry markedly reduced it.

Cuspid's crown tip was previously described on panoramic radiography and CBCT as a sector classifier of the impaction's difficulty, being a valuable tool for identifying impaction and the likelihood of incisor root resorption [25].

The evaluation of maxillary impacted canines using CBCT (three-dimensional) and panoramic radiography (two-dimensional) images has been previously tested, showing a high intra- and interobserver agreement between investigators with orthodontic training [26].

In a study investigating orthodontists' opinion on orthodontic treatment planning using a pictographic tool to show root resorption caused by maxillary canine impaction, it has been shown that cone-beam computed tomography images along with pictograms were closely connected to a general shift in orthodontists' extraction options [27]. We detected a change in the opinion of the majority of respondents when it came to evaluating the difficulty of the impaction on CBCT, being scored 1 point higher compared to panoramic radiography, although it was the same patient. However, in another study, when it came to treatment planning on panoramic and CBCT images, it was similar for impacted maxillary canines [28].

Limitations and Strengths

The limitations of this study are the cross-sectional design that ca not assess the precedence of independent variables over the dependent ones and the observational nature of the study, which comes with confounder bias. Nevertheless, we reduced confounding by using a multivariable regression model; still, residual confounding remained. More questionnaires would have improved the accuracy of the results and would decrease the likelihood of overfitting.

Study strengths are the bilateral evaluation of the difficulty of a case on panoramic radiography and CBCT, and a robust multivariate statistical analysis.

The results are generalizable to orthodontists, prosthodontists, surgeons, and general dentists from Cluj county and the northwestern part of the country.

To the best of our knowledge this is one of the few studies to address dental specialists' perspectives on the evaluation of the cause, severity, complications, and treatment of maxillary canine impaction. One of the novelties of the present study is the comparison between panoramic radiography and CBCT on the same patient in evaluating the difficulty of a maxillary canine impaction. With CBCT introduction in dentistry, there has been a major shift to the three-dimensional image visualization, which enlarge the possibility of an accurate and qualitative diagnosis, as well as an enhanced treatment planning facility. CBCT may be utilized in orthodontics to evaluate side effects brought on by upper canine impaction [29].

In the lateral guiding movement of the jaw, the canine plays a significant functional role. The absence of the canine on the arch may result in working and nonworking interferences, which would throw off the balance of the occlusion. This significant change in the equilibrium of the occlusion curves and the absence of lateral guidance, either canine or group guidance, may cause the start of severe malocclusion, which may be related to the emergence of temporomandibular disorders. Taking into consideration the possible complications that might occur if canine impaction is left untreated, the canine impaction should be managed as soon as possible. Therefore, the impaction could be considered a medical emergency and specialist are urged to find the best possible treatment option for each individual case.

Conclusions

The specialists' knowledge (diagnosis, management, treatment of choice, complications) regarding maxillary canine impaction was appropriate. The specialists with the highest level of knowledge were orthodontists, followed by general dentists, surgeons, and prosthodontists.The younger specialists were better informed than the older specialists. The difficulty of a case was rated higher on CBCT than on panoramic radiography. The difficulty of the evaluated case was perceived to be lower by surgeons than by general dentists. The knowledge of specific treatment options increased the rating of the difficulty of a case (distance from canine cusp tip to the occlusal plane, distance from canine cusp tip to the occlusal plane). The implication of this research is the necessity of updating the knowledge of specialists, related to canine impaction for a better management of patients.

List of abbreviations

CBCT - cone-beam computed tomography

Conflict of Interest

The authors declare that they have no conflict of interest.

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