



ISSN: 0975-833X

Available online at <http://www.journalcra.com>

*International Journal of Current Research*  
Vol. 15, Issue, 06, pp.24980-24985, June, 2023  
DOI: <https://doi.org/10.24941/ijcr.45496.06.2023>

INTERNATIONAL JOURNAL  
OF CURRENT RESEARCH

## RESEARCH ARTICLE

# PROGNOSTIC FACTORS FOR IMPACTED MAXILLARY CANINES: AN OVERVIEW

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### ARTICLE INFO

#### Article History:

Received 14<sup>th</sup> March, 2023  
Received in revised form  
03<sup>rd</sup> April, 2023  
Accepted 17<sup>th</sup> May, 2023  
Published online 30<sup>th</sup> June, 2023

#### Key words:

Impacted, Maxillary, Canines, Prognosis, Classification, Treatment, Factors.

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Citation: Dr. Rochelle Dias, Dr. Himanshu Kanungo, Dr. Mukesh Gupta, Dr. Kratika Mishra and Dr. Akanksha Soni. 2023. "Prognostic factors for impacted maxillary canines: An overview". *International Journal of Current Research*, 15, (06), 24980-24985.

### ABSTRACT

One of the most challenging tasks in the world of orthodontics is the treatment of impacted teeth. The maxillary permanent canine plays the role of preserving the occlusal symmetry and harmony of the soft-tissue. There is a considerable opportunity of impaction because the permanent maxillary canines have a long and complex course of eruption and shift their orientation after striking the lateral incisor root. Over time, a number of prognostic factors have been identified, which have aided in treatment planning. The goal of this review was to provide a bird's eye view on the prognosis of impacted canines and create awareness resulting in interceptive treatment and early recognition.

## INTRODUCTION

Maxillary canines are regarded as the cornerstones of the dental arch and are crucial for both function and aesthetics.<sup>1</sup> The natural eruption process of a tooth might be delayed, even in the presence of a completely formed root, resulting in its impaction. In the world of orthodontics, maxillary canine impaction may be due to a physical obstruction, missing lateral incisors, genetics, systemic disease, primary failure of eruption and/or ankylosis.<sup>2</sup> Maxillary canines, with a frequency of 0.9% to 2.2%, owing to its bulbous root and long tortuous path of eruption, are the second most often impacted teeth after mandibular & maxillary third molars.<sup>3-5</sup> (Table 1). Various theories exist in literature regarding canine impaction, and they can be divided into two categories- genetics and guidance. Impaction of canine controlled by genetics includes the presence of other dental anomalies as stated by Baccetti.<sup>6</sup> 33% of individuals with impacted canines, had other congenitally absent tooth/teeth, according to Peck et al.<sup>7</sup>

Additionally, the predilection of impacted palatal canines is twice in females as in males, proving that sex may also be a contributing factor.<sup>3</sup> According to Bishara et al., possible guiding variables include abnormal eruption rate, defective tooth bud eruption, and delayed resorption of primary teeth.<sup>8</sup> The location of an impacted canine shows the most prevalence in the palatal area with 85% of palatally impacted canines as compared to buccal impactions.<sup>9-10</sup> Palatal impacted canine-to-buccal impacted canine ratios of 3:1 and 12:1 were recorded by Fournier et al<sup>11</sup> and Jacoby<sup>12</sup>, respectively. Furthermore, the most obvious etiologic reason for canine impaction, according to Jacoby<sup>10</sup>, was arch length discrepancy. In this overview, our focus will be on the prognosis of an impacted maxillary canine during orthodontic tooth movement which will be a boon in treatment planning. In addition, the benefits of these prognostic indices which were given over the years, will be outlined. In our knowledge, no study till date has reviewed the prognostic factors for impacted maxillary canines.

**Table 1. Frequency of occurrence of impaction**

Maxillary and Mandibular third molars
Maxillary central incisors
Second premolars
Mandibular cuspids
Second molars
Lateral incisors

**Importance of Canine in Orthodontics:** Canines have a long and bulbous root which maintains the alveolar bone height and provides a youthful appearance on smiling. Orthodontists being a curator of smiles, canines are invaluable to us since they are crucial for preserving the integrity of the arch, the facial harmony, and the functional efficiency. They serve as a bridge between the anterior and posterior occlusion. Furthermore, canines serve as guideposts in occlusion and induce tearing action during mastication. Consequently, we must orthodontically align and preserve the maxillary canine.

### Etiology<sup>2</sup>

#### SYSTEMIC CAUSES

##### *Syndromic cases*

- Familial gingival fibromatosis
- Cleidocranial dysostosis

##### *Non-syndromic cases*

- Multiple supernumerary and impacted teeth
- Hereditary trait for impacted canine
- Idiopathic
- Primary failure of eruption

##### *Associated with Nutrition and Endocrine disorders*

- Pituitary deficiency, thyroid deficiency
- Vitamin D deficiency

##### *Exposure to radiation*

- Leukaemia in young children

#### LOCAL CAUSES<sup>2</sup>

##### *Obstruction*

- Deciduous tooth
- Supernumerary tooth
- Fibrous tissue

##### *Discrepancy between Arch length -tooth size*

##### *Cleft Lip and Cleft Palate cases Trauma*

- Displaced tooth bud
- Dilacerated teeth
- Trauma to primary tooth bud

**Prognostic Factors:** The interlink of an impacted maxillary canine to nearby tissues, the amount of space available, the location, the angulation, the patient's age, and their co-operation are only a few of the variables that might affect the prognosis for orthodontic alignment.<sup>13</sup>

**Sector Classification:** Ericson and Kuroi (1988) discovered that the further placement of the crown of the canine in the mesial direction, the less likely it was to erupt following the extraction of a deciduous

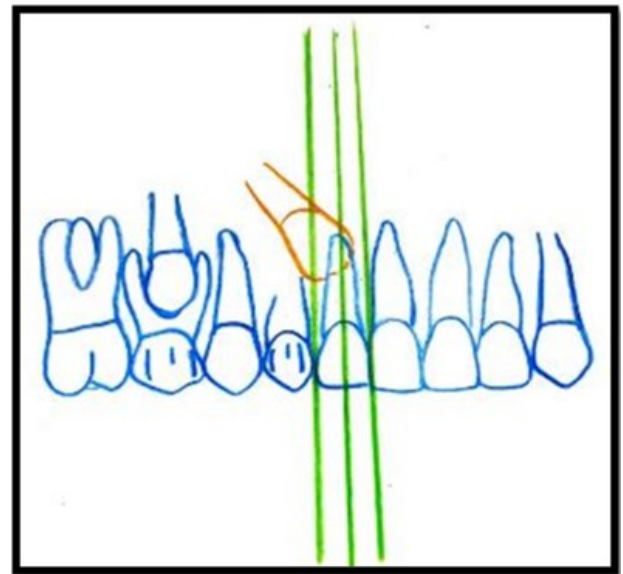
tooth. Lindauer et al. used Ericson and Kuroi's model for the prediction of erupting permanent maxillary canine after deciduous canine extraction. Lindauer (1992) revise this method and made use of the position of the impacted canine's cusp tip and its contact to the adjoining lateral incisor.<sup>14-16</sup> (Fig 1)

**Sector I:** Represents the region that is distal to the heights of the dimension of the lateral incisor's crown & root.

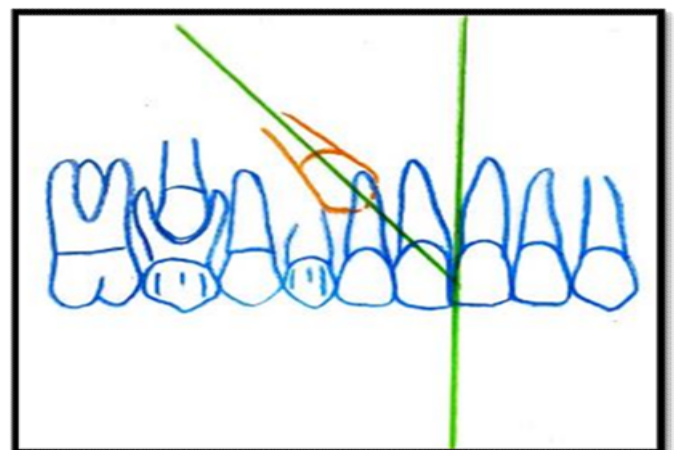
**Sector II:** Represents the distal region to the bisector of the long axis of the lateral incisor and mesial to Sector I.

**Sector III:** Represents the region distal to the mesial heights of the dimension of the lateral incisor's crown & root, but mesial to Sector II.

**Sector IV:** Comprises of all regions mesial to Sector III.

**Fig 1. Sector Classification**

**Power and Short Prediction method (1993):** Power & Short examined the angular view of an impacted canine as a predictor and discovered that if the angle of the tooth to the midline is more than 31 degrees, there is a reduced likelihood that it will erupt following deciduous extraction.<sup>17</sup>(Fig 2)

**Fig 2. Power and Short Prediction method**

**McSherry Prediction method (1996)** Mc Sherry outlined, the impacted canine's alignment prospects are worse, when the position is higher above the occlusal plane.<sup>15</sup>(Fig 3)

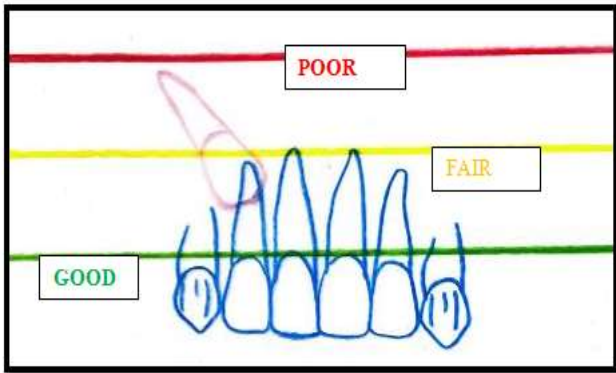


Fig. 3. McSherry Prediction method

**A good prognosis:** When the cusp tip of the canine in question is at the site of the CEJ of the adjoining incisor.

**A fair prognosis:** Is predicted if the cusp tip of the canine is in line with the middle of the adjoining lateral incisor's root.

**A poor prognosis:** Is indicated when the cusp tip of the impacted canine lies beside the apical third of the adjoining lateral incisor's root.

**Warford Prediction method (2003):** Warford et al used the bi-condylar line as a horizontal reference plane. Utilizing the created horizontal plane and the long axis of the unerupted and/or impacted tooth/teeth, the mesial angle was measured. Mean angulation was found to be 75.1° for non-impacted teeth, and 63.2° for impacted canines. An angle of 75° or more means non-impaction.<sup>18</sup> (Fig 4)

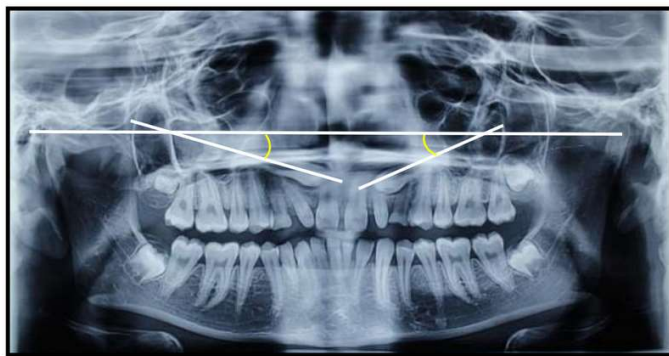


Fig. 4. Warford Prediction method

**Treatment Difficulty Index by Pitt et al (2006):** Pitt et al conducted a study to create an index that could be used to gauge how difficult it would be to align an unerupted maxillary canine during treatment. Scores are allotted based on age of the patient, vertical location, angle made with the midline, horizontal & bucco-palatal position, alignment of maxillary incisors, midline and rotation. The component scores are added to obtain the total score.<sup>19</sup> (Table 2).

Table 2. Treatment Difficulty Index by Pitt et al

Factor	Score	Regression coefficient	Component score
Age	1-4	1.5	
Angulation to midline	1-3	1	
Vertical position	1-4	1.5	
Bucco-palatal position	1	1.5	
Horizontal position	1-4	2	
Alignment of upper incisors	1-3	0.5	
Midline	1-2	1	
Rotation	1-2	1	

Maximum difficulty score = 30 Mean difficulty score =20 Minimum difficulty score = 10

**KPG Index (2009):** Kau, Pan, and Gallerno (KPG) developed a unique grading system based on three distinct perspectives (x,y,z

axes) to determine how severe the impaction is, and the possible effectiveness of treatment. The anatomical position of the canine in question, and its cusp & root tips, are each assigned a digit between 0 – 5, in three different orientations, that are obtained from a pre-treatment radiograph. The total scores of the cusp & root tips, in the antero-posterior and vertical dimension, predicted the difficulty of treatment.<sup>20</sup> Treatment difficulty is divided into three categories: easy, moderately challenging, and virtually impossible. The total scores for each individual tooth are added to create these categories. Scores between 0 and 9 are easy, 10 to 14 are moderate, 15 to 19 are challenging, and 20 and higher are very difficult. The treatment difficulty index was unaffected by position, location, or gender<sup>21</sup> (Fig 5,6,7,8).

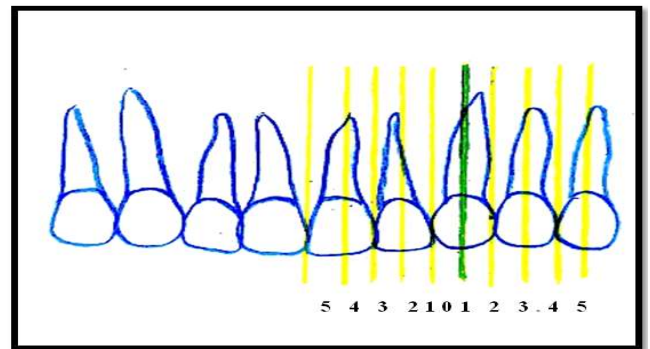


Fig 5. Antero-posterior dimension of cusp tip and root tip (frontal view)

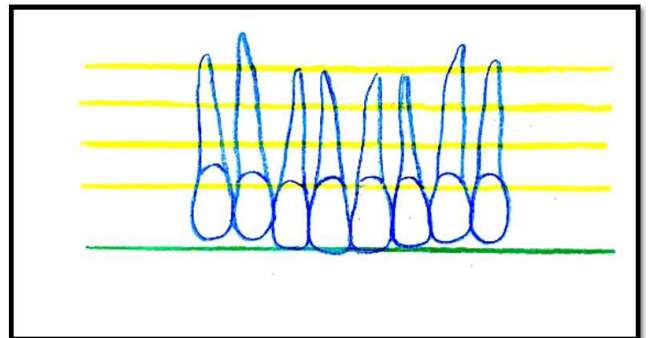


Fig. 6. Vertical dimension of cusp tip (frontal view)

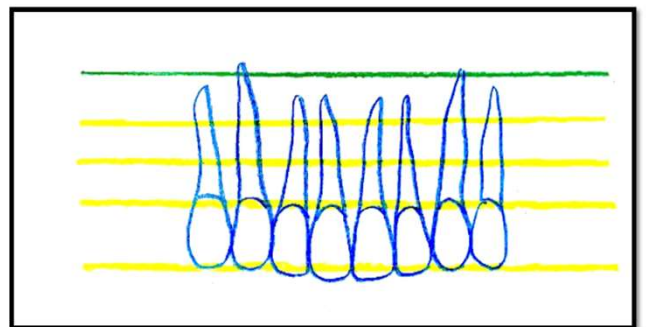


Fig. 7. Vertical dimension of root tip (frontal view)

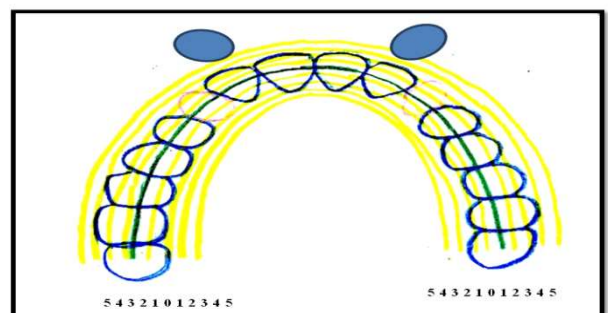
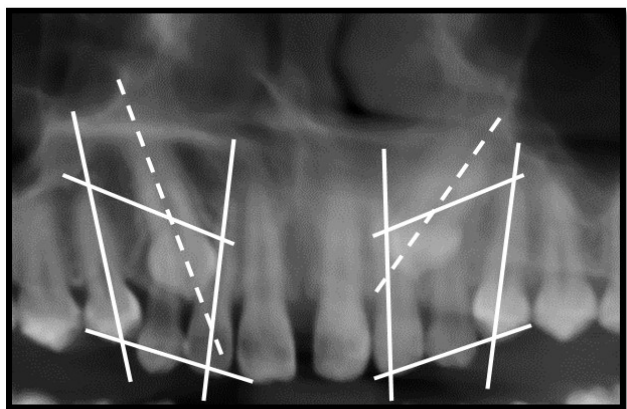


Fig. 8. Deviation from occlusal arch (axial view)

**Easy Box- CBCT study by Muhammed SP (2022):** With the aid of CBCT pictures, the "Easy Box" shows to be effortless, precise, and a quick diagnostic tool during the prognosis of impacted canine cases. The CBCT software is used to select the thickness of the slice and adjust it on OPG constructed view in CBCT at 20 mm. Next, assessment is done to find out if the impacted canine is within the Easy box boundaries. This is followed by the measurement of the Beta angle. (Table 3) The cusp tip of the canine in question lying outside the perimeter of the 'easy box' and having a beta angle more than 45 degrees, was predicted to be more difficult for orthodontic alignment<sup>22</sup> (Fig 9).

**Table 3. Construction of Easy Box**

Borders	OPG Constructed View
<b>Mesial</b>	A line extending from the incisal edge along the long axis till the 3/4 <sup>th</sup> length of lateral incisor
<b>Distal</b>	The long axis of the first premolar from the cusp tip to the superior border
<b>Superior</b>	A perpendicular line is drawn from the 3/4 <sup>th</sup> length of the lateral incisor root to the long axis of first premolar
<b>Inferior</b>	A line connecting the incisal edge of lateral incisor and the cusp tip of first premolar
<b>Beta Angle</b>	Angle between the lateral incisor's long axis and the long axis of the impacted canine.



**Fig. 9. Easy Box on 3D CBCT**

The following prognostic factors applied to a case report: A 20-year-old female patient reported to the Department of Orthodontics and Dentofacial Orthopedics, Index Institute of Dental Sciences, Indore with the chief complaint of irregularly placed and decayed upper front teeth. Patient was unsatisfied with her smile. On extra-oral examination, she presented to have a straight profile with competent lips (Fig 10).



**Fig 10. Extraoral Photographs**

On intra-oral examination, she presented with bilateral Class I molar relationship and retained maxillary deciduous canines with an overjet of 2 mm and overbite of 3 mm (Fig 11). The OPG radiographs and CBCT analysis confirmed bilateral palatal impacted maxillary canines which were rotated 180 degrees with retained deciduous canines.

- Sector classification- IV = Difficult

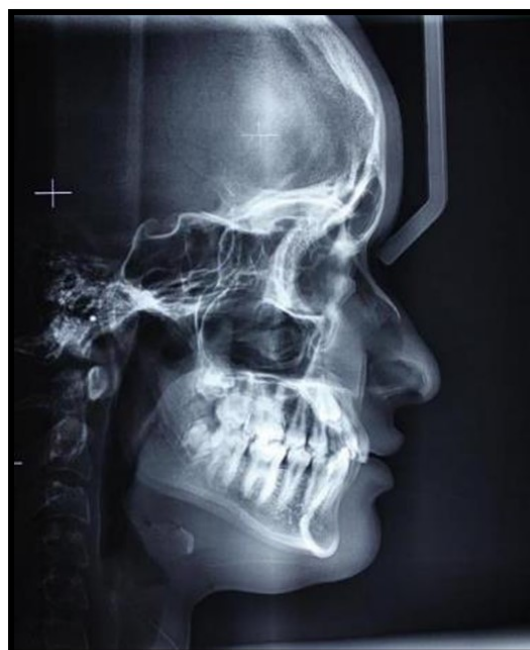
- Power and Short- Less chance of eruption - Left canine= 54° Right canine= 46°
- McSherry = Poor Prognosis
- Warford method- Indicates impaction - Left canine= 35° Right canine= 42°
- Treatment Difficulty Index- Pitt et al (For one canine-27.5, for both canines- 55) TOTAL= 27.5
- KPG Index- (CX=5, RX=4, CY=3, RY=1, CZ=3, RZ=2) = 18 – Extremely difficult
- Easy Box 3D CBCT study- Not within the box, Beta angle- Left canine= 48° Right canine= 47°



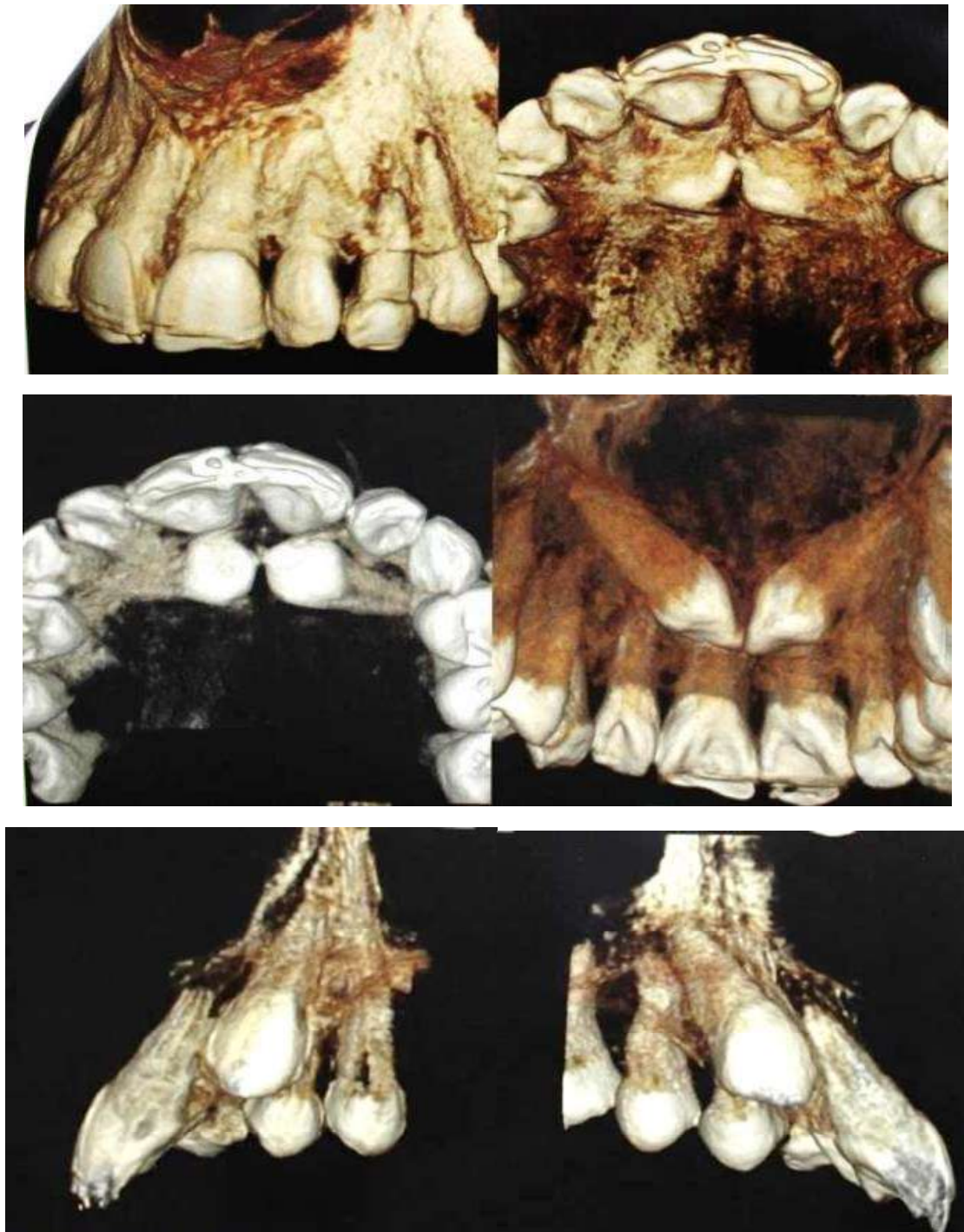
**Fig 11. Intraoral Photographs**



**Pre-treatment OPG**



**Pre-treatment Lateral Cephalogram**



Pre-Treatment CBCT

Factor	Score	Regression coefficient	Component score
Age	4	1.5	6
Angulation to midline	3	1	3
Vertical position	3	1.5	4.5
Bucco-palatal position	1	1.5	1.5
Horizontal position	4	2	8
Alignment of upper incisors	3	0.5	1.5
Midline	1	1	1
Rotation	2	1	2

## CONCLUSION

There are various methods in literature associated with the estimation of prognosis of impacted maxillary canines starting from Ericsson and Kuroi (1988a,b) to Easy box by Muhammed SP et al (2022). It is a challenging task to diagnose impacted maxillary canines due to complex interplay of diverse factors. Prognostic indices have evolved, over the years, from 2D to 3D methods. A better understanding of impactions existing within the dental arch is now possible due to 3D imaging. However, new techniques of classification need to be developed and evaluated 3D methods provide prediction of impacted tooth in all the three planes of space. Despite having plethora of literature, regarding this topic, no literature review was available to the best of our knowledge. Therefore, in this article, we have summarized all the methods available, in a systematic manner, which could act as a ready reckoner for all the dental practitioners, including orthodontists.

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