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Anatomical Characteristics of Impacted Single-Rooted Teeth in a Senegalese Population: A Cone Beam CT Study

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Abstract

Introduction: Impacted single-rooted teeth present a diagnostic and therapeutic challenge due to their topographic and morphological variability. A thorough understanding of their position, root morphology, and associated pathologies is essential. The aim of this study was to investigate the anatomical characteristics of impacted single-rooted teeth using Cone Beam Computed Tomography (CBCT). **Materials and Methods:** This study included 96 impacted single-rooted teeth in 64 patients. CBCT scans were obtained from the dentomaxillofacial radiology department of the IOS, and images were analyzed using CS 3D Imaging software. The parameters assessed included the frequency of impacted teeth by type, root morphology, position in the transverse and sagittal planes, the presence of anatomical obstacles, and associated pathologies, particularly resorption of adjacent teeth. **Results:** The maxillary canine was the most frequently impacted tooth (49%), followed by the maxillary central incisors (23%). Root morphology was normal in 80.2% of cases, with dilaceration observed in 19.8%. In the transverse plane, teeth were mainly positioned buccally (45.8%) or palatally/lingually (44.8%). In the sagittal plane, the vertical position was the most common (39.6%), followed by oblique and horizontal positions (30.2% each). Anatomical obstacles to eruption were present in 12.5% of cases, while 19.8% of teeth exhibited associated pathologies. Resorption of adjacent teeth was noted in 12.5% of cases, mostly mid-root resorption (83.3%). **Conclusion:** These results confirm the value of CBCT in accurately evaluating impacted single-rooted teeth and highlight the need for comprehensive three-dimensional analysis to optimize diagnosis and treatment planning.

Keywords

Impacted Tooth, Single-Rooted Tooth, Cone Beam CT, Anatomical Characteristics

1. Introduction

Dental impaction is a common developmental anomaly that may affect both multi-rooted and single-rooted teeth [1]. However, impacted single-rooted teeth—such as incisors, canines, and second premolars—exhibit specific clinical and anatomical features requiring detailed assessment before treatment [2].

Accurate diagnosis of their position, orientation, and relationship to adjacent anatomical structures is essential to avoid complications during extraction or orthodontic traction [3]. Conventional imaging techniques, such as panoramic or periapical radiography, provide an initial diagnostic approach but remain limited to two-dimensional visualization, which is often insufficient for assessing the spatial complexity of dental impactions [4].

In this context, cone beam computed tomography has become the reference imaging tool in dentistry. It enables detailed three-dimensional analysis, with a lower radiation dose compared to medical CT, while ensuring excellent spatial resolution [5]. With CBCT, the clinician can precisely locate the impacted tooth, assess root morphology, detect potential resorptions or associated pathologies, and optimally plan surgical or orthodontic intervention [6].

The aim of this study was to determine the characteristics of impacted single-rooted teeth (canines, central incisors, premolars) using CBCT in a Senegalese population.

2. Materials and Methods

Study design and population

This study was conducted in the dentomaxillofacial radiology department of the Institute of Odontology and Stomatology, Faculty of Medicine, Pharmacy, and Dentistry, Cheikh Anta Diop University, Dakar.

It was a descriptive cross-sectional study with retrospective data collection. The study population consisted of impacted premolars, canines, and incisors from CBCT examinations performed on patients attending consultations, from December 2024 to July 2025.

Inclusion criteria

- Senegalese patients aged 12 years and older;
- Presence of at least one impacted single-rooted tooth (canine, central incisor, premolar);
- Diagnostic-quality CBCT scan.

Exclusion criteria

- Blurred or incomplete CBCT images;

- Impacted teeth associated with syndromes or congenital malformations.

Sampling was exhaustive, including all records meeting the selection criteria. A total of 64 CBCT scans were included.

Images were acquired using the CS 9600 system (Carestream, Atlanta, Georgia), equipped with pre-installed imaging protocols for various patient demographics (children, small adults, medium adults, tall adults).

Images were analyzed using CS 3D Imaging software, visualized in multiplanar reconstructions in the axial, sagittal, and coronal planes, as well as in 3D volumetric renderings (Figure 1 and Figure 2). Slice thickness was 200 µm.

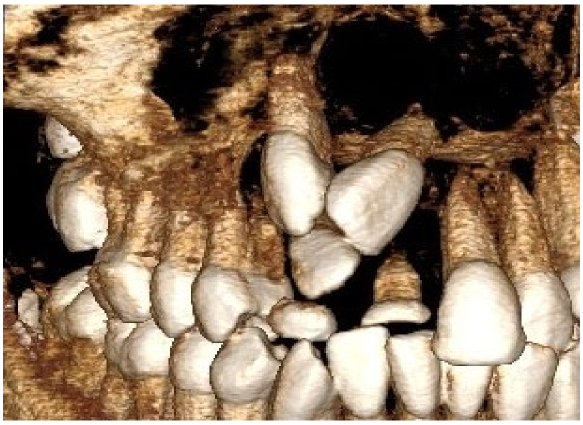

Figure 1. 3D reconstruction of CBCT which highlights the inclusion of 11, 12 and 13.

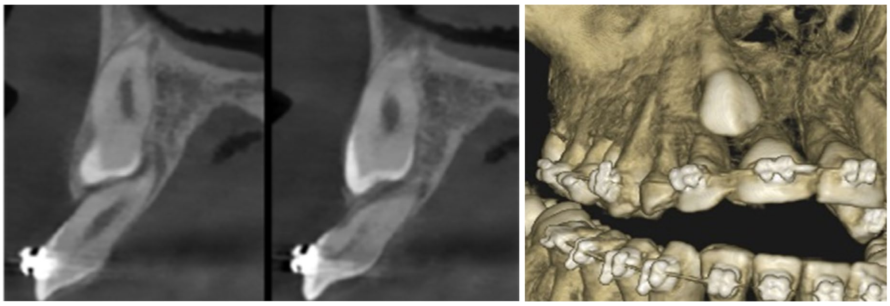

Figure 2. 13 included with normal morphology in vestibular position with radicular of the 12.

A single operator, a dental surgeon specialized in dental radiology with extensive experience in CS 3D Imaging, interpreted the CBCT images.

Variables studied

- Demographic data: age, sex
- Dental characteristics:
    - Tooth type;
    - Position (buccal, palatal/lingual, centered) (Figure 3);
    - Angulation (oblique, vertical, horizontal);
    - Morphological anomalies (dilaceration: an X-ray image of a tooth with a crown in a horizontal position and the root is curved, ankylosis: a tooth whose root is fused to the alveolar bone, thereby eliminating the desmo-

dontal space.) (Figure 4);

- Associated pathologies (adjacent tooth root resorption, cysts, odontomas).

Statistical analysis

Descriptive statistical analysis was performed using JAMOVI software. Quantitative data were expressed as mean ± standard deviation; qualitative data were expressed as frequency and count.

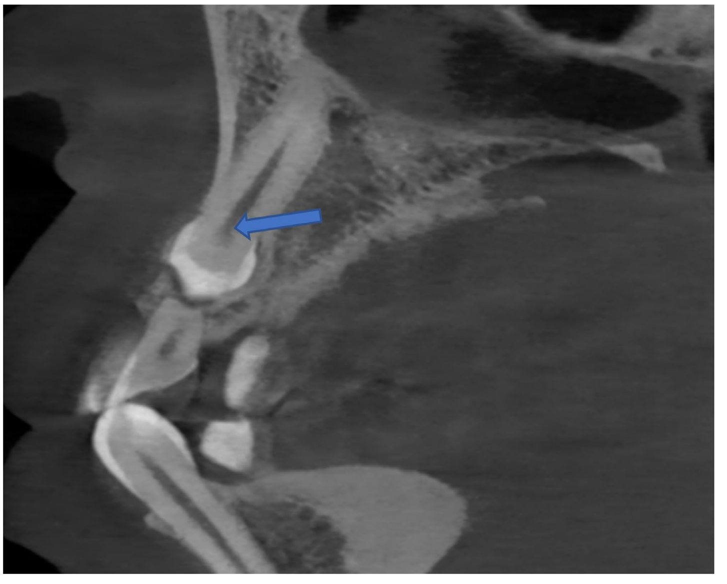

Figure 3. Image showing an impacted canine with a persistent temporary canine.

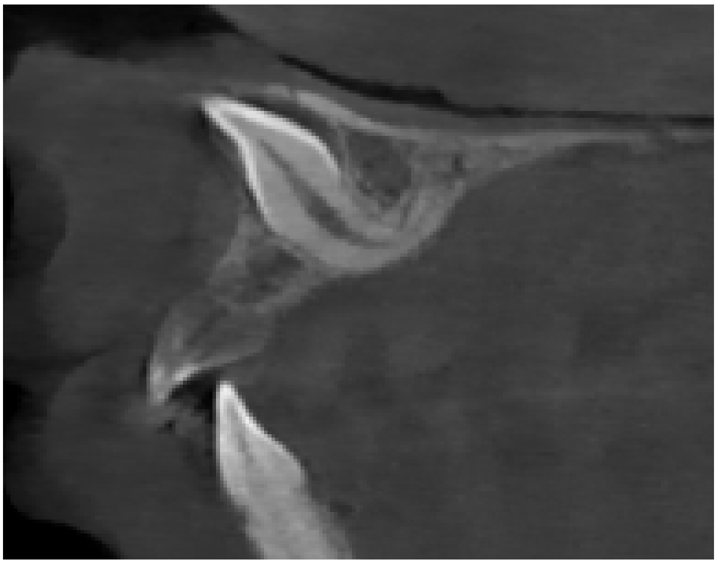

Figure 4. CBCT in sagittal section which highlights the dilacerated 21.

3. Results

The sample consisted of 96 teeth from 64 patients, with a mean age of 19.9 ± 9.93 years. The most frequently impacted tooth was the maxillary canine (49%, n = 47), while the least common was the mandibular first premolar (1%, n = 1) (Figure 5).

Root morphology was normal in 80.2% (n = 77) of cases and dilacerated in 19.8% (n = 19) (Table 1).

In the transverse plane, the most frequent position was buccal (45.8%, n = 44) (Table 2). In the sagittal plane, the vertical position was the most common (39.6%, n = 38) (Table 3).

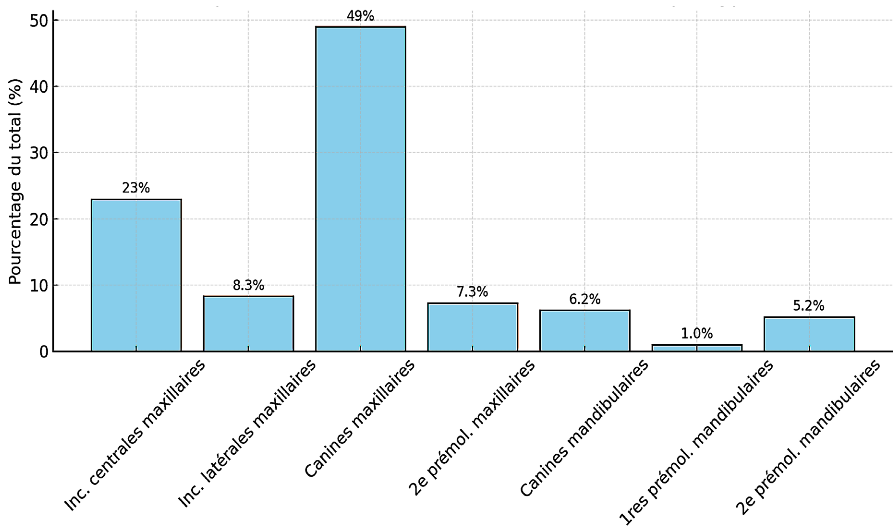

Figure 5. Histogram of frequencies of included teeth.

Table 1. Frequency of morphology of included teeth.

Tooth morphology	Men		Women	
	N	%	n	%
Normal	29	30.2	48	50.0
Dilacerated	**7**	**7.3**	**12**	**12.5**

Table 2. Frequency of tooth positions included in the axial plane.

Axial position	Men		Women	
	n	%	n	%
Vestibular	14	14.6	30	31.3
Palatal/Lingual	19	19.8	24	25
Centred	3	3.1	6	6.3

Table 3. Frequency of impacted teeth positions.

Position	Men		Men	
	N	%	n	%
Horizontal	13	13.5	16	16.7
Vertical	13	13.5	25	26.0
Inclined	10	10.4	19	19.8

Anatomical obstacles were found in 12.5% (n = 12) of cases, most commonly odontomas (59%, n = 7), followed by retained deciduous teeth (33%, n = 4) and supernumerary teeth (8%, n = 1) (**Figure 6**).

Pathologies were associated with impaction in 19.8% (n = 19) of cases, most frequently dentigerous cysts (83%, n = 16), followed by resorption of the impacted tooth (11%, n = 2) and ankylosis (6%, n = 1) (**Figure 7**).

The tooth most frequently affected by resorption was the upper right lateral incisor (tooth 12), involved in 8 cases (66.7% of resorption cases).

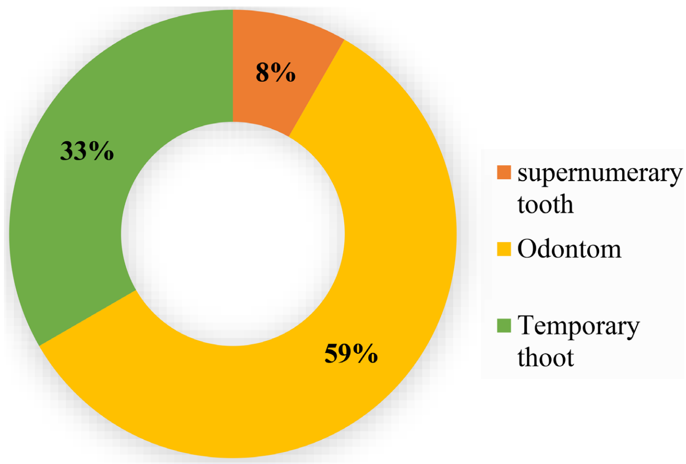

Figure 6. Distribution of anatomical obstacles.

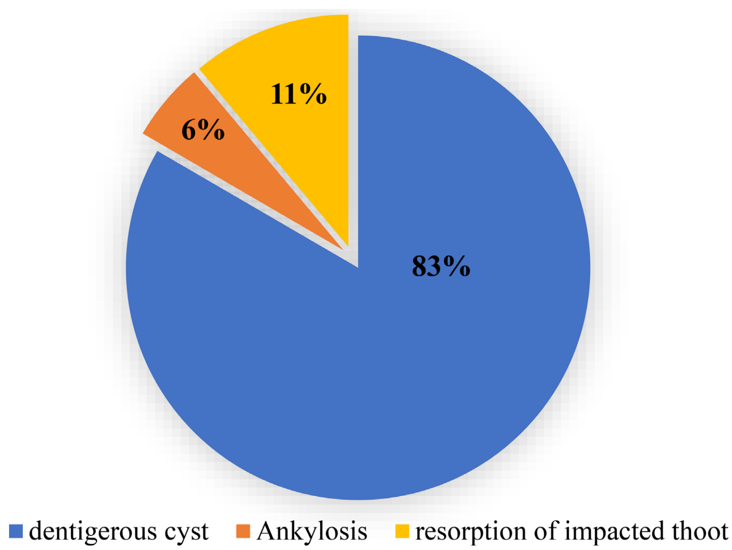

Figure 7. Distribution of pathologies associated with impacted teeth.

4. Discussion

The results of this study provide accurate data on the distribution and frequency of impacted teeth, as well as the conditions associated with them. The main strength of this study lies in the method used, namely Cone Beam CT. This X-ray imaging technique allows for three-dimensional exploration of dento-maxillofacial structures with a single scan. Early non-invasive studies of impacted teeth used conventional radiography, such as panoramic, occlusal or retroalveolar radiography. However, these techniques do not allow for accurate assessment of anatomical relationships due to the phenomenon of superimposition. Today, cone beam CT is the gold standard for the anatomical study of impacted teeth.

Our study looked at a sample of 64 patients with 96 single-rooted impacted teeth. The impaction was bilateral in 32 patients, with an average age of 19.9 years (median: 16 years, range: 11 to 66 years), reflecting a generally young population. Zhou *et al.* [7], in a sample of 145 subjects, reported a mean age of 17.1 ± 3.9 years, with extremes up to 54 years. Shi *et al.* [8] found an average age of 18.6 years. The youthfulness of the populations studied can be explained by the fact that the majority of patients require orthodontic treatment. The gender distribution shows a predominance of females, consistent with higher attendance at orthodontic and cosmetic consultations among women.

The sample of 96 impacted teeth belongs to 64 subjects, which is comparable to certain studies reported in the literature [9]. This population is predominantly young and female, a characteristic often linked to the orthodontic nature of the consultations [7]. Among the impacted teeth analysed, the maxillary canine is the most frequently affected (49%), followed by the maxillary central incisors (23%). The mandibular first premolar is the least frequently affected (1%). Shi *et al.* [8] report a similar prevalence of 52.45% of impacted maxillary canines in a Chinese population. Sajnani and King [10] observed a frequency of 2.1% for maxillary canine teeth in a southern Chinese population, with a predominance of unilateral inclusions (82.9%). Zhou *et al.* [7], in 157 patients with 205 impacted teeth, report an overall prevalence of 7.26%, with maxillary canines being the most affected (39.51%), followed by maxillary incisors (30.24%). Thus, the canine remains the tooth most affected by impaction, although its spatial position is variable.

According to Grisar *et al.* [11], who studied 162 impacted maxillary canines, the classification is based on four criteria: vertical crown position, mesiodistal position, vestibulolingual position, and associated pathologies. The most common positions are vertical position of the crown in the apical third of the adjacent teeth, mesiodistal angulation, and palatal position. Yu *et al.* [12], in a study of 22 adolescents, showed that the majority of impacted canines were mesially inclined. The mesial inclination relative to the occlusal plane varies between 53.8˚ and 68.5˚. Yan *et al.* [13], in a study of 170 Chinese subjects aged 12 to 30 years (average age 14.5 years), examined 170 impacted canines (101 vestibular, 69 palatal). Lai *et al.* [14], in a study of 134 impacted canines, reported 51.49% in the palatal position, 30.60% in the vestibular position and 17.91% centred in the alveolar process.

Knowledge of the topography and morphology of the canine tooth is a key factor in the therapeutic prognosis. The vestibular position of the crown on Cone Beam CT suggests a vestibular surgical approach. The spatial position in relation to neighbouring teeth and the root morphology influence the therapeutic strategy.

A dilacerated or ankylosed tooth is often extracted. The presence of associated pathologies, such as dentigerous cysts, constitutes a poor prognosis for the overall management of the impacted tooth. Although the radiological diagnosis of dentigerous cysts can be made by panoramic radiography, Cone Beam CT allows a more detailed assessment of the condition of the cortices, the size of the cyst and its effects on the anatomical environment [13].

Tooth resorption of adjacent teeth was observed in 12.5% of cases, with a predominance in females. The upper right lateral incisor is the most frequently affected tooth, involved in 66.7% of resorption cases. The location of resorption is mainly in the middle root (83.3%), with apical and coronal resorption remaining rare. Ng *et al.* [15], in a study of 145 canines, found that maxillary lateral incisors had the highest prevalence of root resorption (38.5%), with the apical region being the most common site (20.9%), with varying degrees of severity (mild 10.1%, moderate 15.6%, severe 12.8%).

The roots of the maxillary lateral incisors are therefore particularly vulnerable in the presence of an impacted maxillary canine. Clinicians must take into account the extent, location and severity of this resorption when planning treatment [16]. After the canine, the central incisor is the second most commonly dilacerated tooth, as highlighted in the systematic review by Mockutė *et al.* [17].

In our study, the majority of teeth had normal morphology. Dilaceration was observed in 19.8% of cases, with a slight predominance in females. In the transverse plane, impacted teeth were mainly in the vestibular position (45.8%), followed by the palatal/lingual (44.8%) and centred (9.4%) positions. In the sagittal plane, the vertical position was the most common (39.6%), followed by oblique and horizontal positions. Impacted incisors are often associated with anatomical obstacles such as odontoma, ankylosis or a bulb on the root of an adjacent tooth. The maxillary central incisor remains the most dilacerated tooth [18].

Hui *et al.* [19], in a study of 94 impacted incisors, identified 35.11% of dilacerated roots, 18.09% of retained primary teeth, 15.96% of supernumerary teeth, and 15.96% of cases with a history of trauma. Impacted incisors were most often vestibular (69.15%), followed by vertical (18.09%) and palatal (12.77%) forms. These anatomical differences can be explained by interindividual variations related to the ethnic group studied, but also by the sample size and the study method used.

5. Conclusion

The method used in this study proved reliable, reproducible, and highly informative, enabling precise assessment of impacted single-rooted teeth. Cone beam computed tomography is a highly accurate tool for three-dimensional evaluation of dental impactions. The results contribute to a better understanding of their radiological aspects and can guide clinicians in diagnosis and treatment planning.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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