The Morphology of Impacted Maxillary Central Incisors

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There is no difference between impacted teeth and their contralateral crowns, or a minor decrease in impacted maxillary central incisors (ICI) crown length (from 0.15 to 0.56 mm). The root lengths of impacted maxillary central incisors were considerably shorter than contralateral incisors (from 2.13 to 3.22 mm) and, as dental age increased, root growth decreased and the incidence of root dilaceration was more frequent.

Keywords: impacted ; maxillary central incisors ; crown length ; root morphology ; root length

1. Introduction

The impaction of maxillary central incisors is the third most common impaction (with an incidence of approximately 0.03–2.1%) [1][2][3] after the third molars (approx. 24.4%) [4] and upper permanent canines (approx. 2%) [5][6]. Although the impaction is relatively rare, it poses a huge challenge for both the patients and the professionals. Due to the specific location of the central incisors, their absence has a significant impact, not only on the person's facial aesthetics, but also on function, phonetics, and psychology [7][8][9][10][11].

The impaction of central incisors is of multifactorial origin. The key components involved are supernumerary teeth, odontomas, and trauma. Supernumerary teeth and odontomas are the most common cause of delayed eruption of maxillary incisors with 56–60% of supernumerary teeth causing an impaction due to a direct obstruction to eruption [12][13]. Another reason for a failed eruption is tooth malformation or dilacerations. Dilacerations are often caused by trauma to a primary tooth, where the developing permanent tooth bud is affected because of the close proximity to the primary tooth. This leads to the development of root curvature in the labio-lingual or medio-distal direction [14][15]. The position of root dilaceration of the permanent central incisor depends on the developmental stage of the tooth at the time of injury [16]. In contrast, in some dilaceration cases, there are no signs of traumatic origin, therefore it is suggested that this anomaly is likely to be caused by the ectopic development of tooth buds [17]. Further possible causes of impacted maxillary central incisors may also be attributed to other morphological and positional abnormalities, such as ectopic position of the tooth germ, pathological obstructions in the eruptive path, non-vital or ankylosed primary incisors, early loss of deciduous teeth, mucosal barriers, endocrine abnormalities, and bone disease [18][19][20][21].

Diagnosis of the impacted or nonerupted teeth is usually made based on clinical and radiographic findings. Retention of the primary tooth, insufficient space in the region of an unerupted tooth, late eruption, and atypical elevation of the soft tissue of the palatal or labial mucosa are all clinical symptoms of an impacted tooth [22]. Radiologic evaluation is necessary to confirm the presence of tooth impaction, the position and orientation of the impacted tooth, and the possibility of the adjacent teeth root resorption. However, preoperative determination of the morphology of an unerupted tooth is also an important factor in diagnosis and treatment planning. According to Lin et al. [23], the prognosis for orthodontic traction is better for a tooth in a lower position in relation to the alveolar crest, dilacerated root with an obtuse inclination angle, and incomplete root development. Conventional radiography cannot always demonstrate structures in all three planes, and frequently an image is obscured because of superimposition on other structures. Bodner et al. [24] analysed image accuracy of conventional radiography and computerized tomography (CT) when assessing impacted teeth. The result showed that the crown shape, root shape, crown/root relationship, and tooth inclination were significantly more clearly shown on CT than they were on two-dimensional radiography. Lately, cone-beam computed tomography (CBCT) is widely used as a diagnostic tool for impacted teeth. Not only are the effective doses smaller than those of medical CT, but also it is more time-efficient, more cost-effective, and still able to provide 3D images with an unlimited number of views [25][26].

2. The Morphology of Impacted Maxillary Central Incisors

Evaluating root morphology is imperative for rational treatment planning, particularly selecting appropriate therapeutic timing and protocol of impacted maxillary central incisors, as well as the probability of a spontaneous eruption. Treatment of upper permanent impacted incisors includes early interceptive measures to facilitate the eruption of displaced maxillary incisors or surgical exposure of the tooth's crown with the subsequent orthodontic alignment of the tooth. A successful alignment of an impacted tooth depends on several factors: the position and direction of the ICI, the degree of root formation, the degree of dilacerations, and the presence of space available for the impacted tooth [23][27][28][29][30][31]. In various studies, the recorded rate of spontaneous eruption ranges from 30.3% to 89.4% of cases and is dependent on the initial maturation of the impacted tooth's root, initial vertical position, and degree of angulation of the impacted incisor, the form of the obstacle, and additional orthodontic expansion of the dental arch [32][33][34][35]. However, in some cases, impacted incisors do not erupt, and surgical-orthodontic treatment is needed.

Not only root growth decreases, but also incidence and severity of root dilaceration increase as dental age increases because the root develops in an irregular direction. A significantly higher dilaceration angle was observed in the early dental age group than in the late dental age group by 32.75° [36]. The more the angle is obtuse, the less the root is distorted. It is possible to speculate that the earlier the dilaceration begins to form, the closer it is located to the cervix, therefore limited space is available for further root development. However, results about the localization of dilaceration are conflicting [36][37]. This may be due to different study samples. Moreover, none of the analysed studies included the dilaceration measurements of contralateral incisors, due to that the comparison was not possible.

The aetiology of dilacerations is yet not fully explained, however, there are two possible versions: trauma or idiopathic developmental disturbances [38]. It is claimed that root dilaceration is usually prominent in affected permanent maxillary incisors due to its close topographic relationship with deciduous teeth, which are commonly injured [39]. The injured Hertwig's epithelial root sheath produces dentin at the same rate as before the injury and tends to grow in an atypical upward and lingual direction independently of its crown direction [38]. Studies point out that early management of impacted maxillary central incisors (ICI) is needed because it is easier to treat the inverse tooth with shorter roots as the centre of rotation is nearer to the cervix of the tooth [36]. After early correction, the impacted tooth's root can grow in a proper way [40].

Lyu et al. [37] stated the importance of exploring the different types of impactions to determine effective prevention and treatment for dilacerated ICI. The treatment and prognosis of teeth differ with the direction of the crown, degree of dilacerations, root formation stage, and position [23][37]. The nearer the dilacerated position is to the cervix, the worse the prognosis for orthodontic traction. In contrast, obtuse angle root dilacerations and incomplete root formation are prone to success [23]. Both Sun et al. [36] and Rizzatto et al. [41] strongly recommended starting the treatment as soon as possible for the purpose of eliminating the aetiological factors, making room for the impacted tooth's full root development, and facilitating future treatment. Lyu et al. [37] suggested that treatment should begin no later than the closure of the apical foramen in impacted ones. Adequate treatment time allows Hertwig's epithelial root sheath to be redirected, allowing the root to develop normally [38]. Additionally, early treatment corrects an inverse tooth more easily since the root is shorter [36]. Late treatment can result in delayed tooth eruption, midline shift, migration of adjacent teeth, loss of alveolar bone crest, and other obstacles for future treatment [42].

Studies demonstrated an inconsequential difference between the crown lengths of impacted maxillary incisors and contralateral incisors. Contrarily, the impacted maxillary central incisors' root lengths were significantly shorter compared to the contralateral incisors. Moreover, the incidence of root dilaceration increased as dental age increased. However, results concerning the localization of dilaceration are conflicting, further research with larger populations is needed for more reliable conclusions and clinical guidelines.

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