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Research Article

Prevalence of C-shaped Root Canal Configuration in Second Mandibular Molars in Two Private Dental Offices Held in Romania and their Endodontic Approach

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Abstract

The endodontic management of C-shaped canals in mandibular second molars is challenging, starting from the diagnostic stage and then with the chemomechanical treatment and obturation, corresponding to the standards of endodontics principles.

Materials and Methods: Cone-beam computed tomography (CBCT) scans from 153 patients, were screened, assessing the axial sections for C-shaped configurations.

Results: A total of 157 mandibular 2nd molars were studied. The prevalence of C-shaped mandibular second molars was 7.64% (n = 12). 25% (n = 3) were found in male patients and 75% (n = 9) in female patients

Conclusion: Our study, carried out with the help of Cone-Beam Computed Tomography (CBCT), a reliable imaging method especially for the identification of C-shaped canal's cases that are less encountered in practice, shows the prevalence of this configuration in a Romanian population and proposes practical methods of clinical management for this morphological type.

Keywords: Anatomy; C-shaped Root Canals; Prevalence; Endodontic Treatment

Introduction

The success of the endodontic treatment depends both on the detailed knowledge of the usual anatomy and the various configurations, as well as on its maintaining during the chemomechanical treatment. The C-shaped configuration of mandibular second molars is one of the most difficult endodontic system. Early identification of this morphological type leads to its treatment without further incidents [1].

This endodontic anatomical configuration is different from the usual morphology of the lower molars, either the typical one with

2 roots and 3 or 4 canals, or even with 1 or 3 roots. The name of this morphological variant derives from the shape of these teeth on the horizontal section, in the shape of the letter „C". Their main feature is the presence of an isthmus connecting the main canals and thus, their orifice has the appearance of a single ribbon with a 180° opening [2].

However, considering that there are also cases when these canals do not have this configuration along the entire length of the root, they are considered canals C-shaped, only when at any level, the axial section looks like a „C" [3].

Although it is found more often in the case of the second mandibular molars, it has also been noted at the level of the mandibular premolars, but also the second maxillary molars, however to a lesser extent [4,5].

The prevalence of this configuration varies greatly worldwide, from Asian populations, with higher values, of 44%, to lower values for other populations [1-3].

The aim of this article is to show the prevalence of 2nd C-shaped molars in a Romanian population and to indicate clinical management aspects of these endodontic configurations for a successful outcome.

Material and Method

There were retrospectively evaluated existing CBCT images from a pool of CBCT scans taken for routine diagnosis and treatment planning in 153 patients, who visited two private dental offices, over a period of 5 years, 2018-2023.

The CBCT images were acquired with Veraviewepocs 3D P (R100) equipment (J. Morita MFG Corp., Kyoto, Japan). The scan parameters were 90 kV, 5 mA, 9.4 s exposure time, 125 µm spatial resolution and 40×40 mm field of view (FoV). All CBCT exposures were performed with the minimum exposure necessary for adequate image quality. The selection of CBCT scan followed as inclusion criteria of the good quality of radiographic images, fully erupted mandibular molars and absence of root canal calcification.

Results

There 157 mandibular 2nd molars. The prevalence of C-shaped mandibular second molars was 7.64% (n = 12). 25% (n = 3) were found in male patients and 75% (n = 9) in female patients.

Discussion

Prevalence

The most accepted theory regarding the formation of this type of configuration is the lack of fusion of the Hertwig epithelial sheath: at the vestibular level, it leads to the formation of a groove in the lingual area and vice versa, a thin strip connecting the two roots. Studies have clearly shown an ethnic predilection for this endodontic variant, therefore of genetic origin [6]. This increased incidence for mandibular 2nd molars in certain ethnicities has been highlighted by numerous studies in the literature. Thus, the populations of the East Asian area present among the highest incidences: 39% for China [7], 45.5% Korea [8], and in another study for Korea, 39.8% [9]. This racial predilection for this morphological type, with a maximum of 93.1% for China (Asia) and a minimum of 2.7% for America, was also confirmed by other studies [10]. A study that included endodontically treated molars from patients at a private clinic in Germany, out of 901 cases, 15 were C-shaped (1.66%) [11]. In Iraq, the incidence was 17.4% [12], and in an Australian population, 13% [13]. As it can be seen, our results are among the minimum values of this configuration, but still, they are not the lowest.

In addition to racial predilection, right-left symmetry was also observed, that is, when it is present on one side of the mandible, in over 70% of cases the contralateral is of the same type, in C [14].

In addition to these aspects, this configuration seems to be more common in the female gender, as we also observed in these studies [5,8,9].

Preoperative diagnosis

The first difficulty raised by these teeth is that of preoperative diagnosis, of recognizing this configuration before starting the endodontic treatment, since all the steps of endodontic treatment need to be adapted to this anatomical particularity. Periapical radiography rarely provides clues to suggest this anatomy [15], perhaps after multiple cases adding to clinical experience, it may become predictable. On the preoperative periapical radiograph, as a clue to identify this configuration, there appear to be either 2 roots close together, clearly converging towards the apex (Figure 1), or a single root, and Haddad also adds the image of a wide distal canal, a narrow mesial canal and the blurred image of the third mesial canal [16]. In the coronal and middle part, 2 separate canals

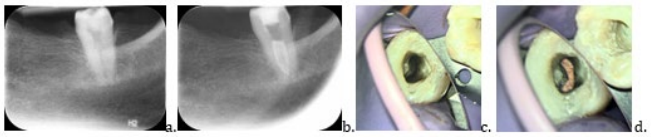

Figure 1 : Clinical example of a C-shaped left mandibular second molar a. preoperative radiograph b. postoperative radiograph c. clinical image d. filled root canals.

are observed, because the isthmus between them is very thin, on one hand, and on the other hand, it is oriented in such a way that it cannot be observed radiologically, and the characteristics of this system are difficult to be recognized due to the overlap of the mandibular bone [17].

Undoubtedly, being visible on the horizontal section, it is precisely highlighted by CBCT, as preoperative imaging (Figure 2). High-resolution CBCT has been shown to be much more accurate than periapical radiography [18].

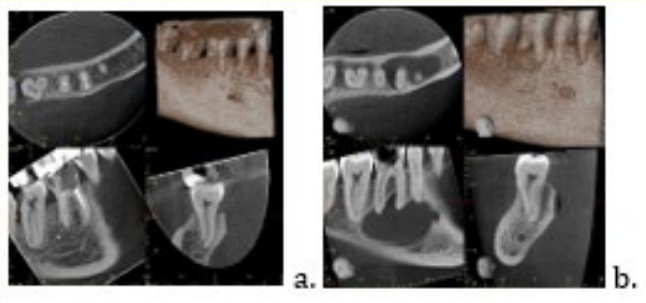

Figure 2: a, b second mandibular molars with C-shape configurations, CBCT images.

In the absence of this scan, it is identified when the pulp chamber is opened, if we have the magnification provided by the dental operating microscope and coaxial illumination, the microscope image being in fact what is seen on the axial section of a CBCT scan. But a CBCT scan shows us not only the specific C-shape, but more importantly, the number of channels, their shape and disposition, their diameter, and also the isthmuses between them, characteristic of this configuration, as they can be extremely varied. This information can also be gathered with the microscope, but sometimes it is more difficult and requires the invasive action of additional ultrasound removal of the dentine to be sure that there is no additional anatomy at risk of being missed. In the last case, we can no longer be minimally invasive, resulting in a fairly wide endodontic footprint. CBCT correlated with the dental operating microscope are essential for successful management of this setting [19].

Endodontic treatment

Considering that the success of the endodontic treatment depends primarily on the chemo-mechanical approach and debridement, followed by the endodontic sealing of the entire endodontic system, it is understandable that it is imperative to also understand this morphological feature [20].

The presence of a complex anatomy, with transverse anastomoses, lateral canals and apical deltas, determines the difficulty of a mechanical treatment and correct obturation [21]. Although fusion, calcification, and curvatures can influence canal negotiation, however, the most important factor influencing this step is actually canal bifurcation. This can occur at any level and it is recommended to use a curved file to locate them.

After opening the pulp chamber, the root canal orifices are identified, which are no longer classically positioned, as for a lower molar, but one of the 2 mesial canals is located in the convexity of the C. The distal canal is elongated bucco-lingually. The mesial canals can be separate or with a common apex. It can also be the second distal canal, as well as with separate or common apex [22]. Fan showed that none of the orifice was found at the level of the cemento-enamel junction (CEJ); only about 1/4 were found at a level 1 mm below. Nearly all (98.1%) could be found within 3 mm below the CEJ [22].

After establishing the working length, the rotary treatment of these canals must be done carefully, especially when inserting instruments into the canal, to be in its direction and not in the isthmus or in the wrong direction from their divergence or convergence. Otherwise, the instruments may fracture in the root canal, with negative consequences for the prognosis of endodontic treatment [21].

In the case of this configuration it is more than obvious that mechanical instrumentation will leave a large area of the endodontic isthmus undebrided. However, there are studies that show that

the use of the self-adjusting file system can bring a significant difference in the mechanical cleaning of this morphological type, with 20% less untouched endodontic system, compared to classic rotary systems [23,24].

Another important aspect when shaping these canals is to preserve as much of the thickness of the root walls as possible, so necessary for the resistance of these molars to the masticatory forces and the prevention of root fractures [25]. These authors have showed in their study that after the rotary treatment with nickel-titanium files, more dentine of the C convexity was removed in the apical area than in the furcation area and the opposite phenomenon was observed in the coronal part.

The endodontic irrigation performed with the classic sodium hypochlorite solutions must necessarily accompany the mechanical treatment, not only for the lubrication of the instruments, or its antiseptic effect, but it is equally important to prevent the compaction of the debris resulting from the mechanical treatment in the isthmuses between canals, specific to this configuration and where they can extend from the floor of the pulp chamber to the apical level. Blockage of these fine anatomic structures with debris results in compromising the cleaning of the endodontic system in its entirety and its subsequent failure. Thin, side-opening, safe and flexible irrigation cannulas are currently available, which can reach even 1mm of working length without the need for excessive root canal widening, which compromises the subsequent strength of these teeth. For example, the new plastic cannulas can be inserted into a curved canal up to 1 mm from the apex, after a 0.20 mm widening 4% taper.

The presence of isthmuses has already been correlated in the endodontic literature with the predisposition to vertical root fractures, being considered areas of minimal resistance [26]. Thus, using the technical equipment we currently have, we can achieve the goals of the chemomechanical treatment, without affecting the strength of these teeth.

Unfortunately, the isthmus area cannot be reached by endodontic files and thus these structures will be chemically cleaned, through the action of sodium hypochlorite, which can reach them through its additional activation by various means, sonic, ultrasonic, laser.

Root canal filling is another problematic step in this setup. For filling materials to reach inside these structures, warm gutta-percha compaction techniques are most recommended, the vertical compaction force of the gutta-percha forces sealers and even plasticized gutta-percha into the canal communications.

On the postoperative X-ray, the specific image looks like a veil, like a curtain, the clear proof that the communications between the canals were also filled.

It was found that the most common cause of failure for a C-shaped root canal treatment was a leaky canal (45.2%), followed by an isthmus (23.8%), missing canal, overfilling, and iatrogenic problems [27]. This is due to the complexity of this endodontic anatomy, which renders the endodontic clinical management of these teeth challenging, in terms of locating all the main canals, then to clean the isthmuses and finally to fill them.

It is desirable that the endodontic treatment of these types of teeth is carried out to the recommended standards from the beginning, as endodontic re-intervention can be a nightmare, especially the removal of pre-existing materials from the isthmuses.

When faced with C-shaped molars, it would be ideal to have them CBCT scanned for a better preoperative understanding of the endodontic system. The irrigation stage is extremely important for isthmus debridement; endodontic obturation is performed homogeneously in these situations by means of warm gutta-percha compaction techniques.

Conclusions

Considering that all stages of the endodontic treatment need to be adapted for a successful root canal therapy of this morphological type, it is imperative that it could be identified from the beginning by means of high-resolution imaging, like CBCT and individualize the endodontic treatment methods.

Our study emphasizes the value of knowledge of detailed endodontic anatomy and also of using advanced diagnostic tools for a successful clinical approach of these complex cases.

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