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Endodontic Management of Hypertaurodontic Teeth: A Report of Three Cases

Ali Chamani [a*], **Mina Zarei** [a], **Pouria Soltaninezhad** [b], **Seyyedeh Zahra Jamali** [b], **Pegah Sadeghnezhad** [b]

a Department of Endodontics, School of Dentistry, Mashhad University of Medical Sciences, Mashhad, Iran; *b* Private Practice, Mashhad, Iran

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****Corresponding author***: Ali Chamani, Park Square, Vakilabad Blvd, School of Dentistry, Mashhad, Iran, Postal code:1461965381.

E-mail: alichamani73@gmail.com

Taurodontism is a dental anomaly characterized by the absence of cervical constriction at the cemento-enamel junction, apical shifting of the pulpal floor, and an expanded pulp chamber. This condition presents unique challenges in endodontic diagnosis and treatment due to its variable morphology, deeply located orifices, and complex root canal system. This paper reports three cases of hypertaurodontism (Taurodont Index ≈ 50), including a maxillary first molar, mandibular third molar, and mandibular second premolar in systemically healthy patients. The identification and treatment planning were facilitated by cone-beam computed tomography (CBCT). Root canal therapy was performed under a dental operating microscope, with careful exploration, chemomechanical instrumentation using rotary files, copious irrigation with 5.25% sodium hypochlorite, and warm vertical obturation. Twelve months later, follow-up visits showed that all patients were clinically and radiographically asymptomatic, indicating successful outcomes. Taurodontism presents significant challenges due to its anatomical complexities. A multifaceted approach involving CBCT, dental operating microscopes, ultrasonic irrigation, and warm vertical obturation is recommended. This case series demonstrates that with advanced diagnostic aids and meticulous techniques, even hypertaurodontic teeth can be effectively managed.

Keywords: Anatomic Variation; Cone-beam Computed Tomography; Root Canal; Taurodontism

Introduction

A dental anomaly known as taurodontism is described by an absence of cervical constriction at the cementoenamel junction (CEJ) level and an expanded pulp chamber with apical displacement of the pulpal floor. The reason for this variation in tooth morphology is that the epithelial root sheath diaphragm of a twig fails to permeate at the appropriate horizontal level during tooth growth [1-4].

According to Witkop taurodontism is defined by the presence of larger pulp chambers in teeth than in normal teeth, with the bifurcation or trifurcation displaced apically, thereby increasing the apicoocclusal height of the chambers[5]. The term “taurodontism” was first employed in 1913 in accordance with Gorjanovic-Kramberger’s 1908 description [2-4].

Since taurodonts lack cervical constriction and have lengthy clinical crowns [6-8], they seem cylindrical in three dimensions as opposed to rectangular in two [9]. Several factors contribute to the etiology of taurodontism, including the formation of the cynodont, which having small pulp cavity, due to insufficient invagination of the epithelial root sheath at an early stage [9]. Two additional hypothesized etiological causes are odontoblastic deficiencies during root dentin generation [10] and disrupted developmental homeostasis [5]. Ectodermal dysplasia [11], Smith-Magenis syndrome [12], thalassemia major [13], tricho-dento-osseous (TDO) syndrome [14], cleft lip and palate [14], and Van der Woude syndrome [15] have all been linked to taurodontism. Although some studies point to a link between multiple taurodontism and systemic disorders [16-18], some contrary findings have also been published [19, 20].

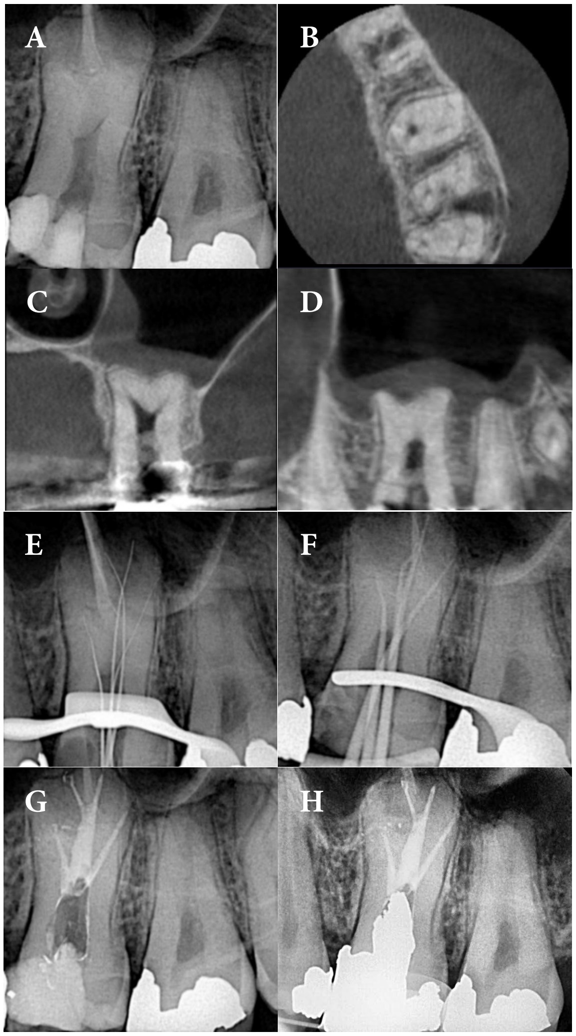

Figure 1. *A*) A preoperative radiograph; *B*) Axial view of preoperative CBCT scans, *C*) Coronal view of preoperative CBCT scans; *D*) Sagittal view of preoperative CBCT scans; *E*) A radiograph with K-file confirming the root canals working length; *F*) A master-cone fit confirmation radiograph; *G*) A postoperative radiograph taken after root canal treatment and tooth temporization; *H*) A 12-month follow-up radiograph

When a taurodont tooth is present, dentists may be the first to diagnose an underlying syndrome [21]. Taurodontism is now understood to be an anatomical variation in everyone, even though it was once assumed to be connected to syndromes like Downs and Klinefelters [22]. Taurodonts are mostly located in permanent and deciduous premolars and molars, with a notably greater occurrence in the second maxillary permanent molars [9]. A single tooth or multiple teeth may be affected, the distribution of the teeth may be unilateral or bilateral [20], and about 50% of the cases show bilateral involvement. There are particular populations, such as Middle Eastern and Eskimo tribes, where taurodontism is more common. Clinically, the size of a taurodont tooth is usually normal; permanent dentition molars are more commonly affected. Radiographic examination is crucial for identifying taurodonts because of their unique appearance. Rectangular pulp chambers extend into the elongated tooth body, have attenuated roots and a root canal furcation at the root apices, and lack cervical constriction [21, 23]. Depending on how severe the condition is, taurodonts can be further divided into hypotaurodonts, mesotaurodonts, and hypertaurodonts [24]. To detect taurodontism from radiographs, Shifman and Chananel [25] suggested a quantitative technique called the Taurodont Index (TI). After dividing the pulp chamber's height by the distance between its occlusal end and the root apex, the TI is calculated by multiplying the value by 100. A tooth is diagnosed with taurodontism if the TI is 20 or higher. The diagnosis and assessment of taurodontism should be aided by cone-beam computed tomography (CBCT) imaging. In this respect, the use of a biometric method has mostly relied on two-dimensional (2D) periapical or panoramic radiographs. However, these radiographs may not precisely depict the actual measurements of all parameters. Thanks to CBCT scanning, clinicians can assess this tooth abnormality's size and morphology in great detail [15, 19, 26]. The present study aims to address the suggested procedures and safety measures for the effective endodontic treatment of teeth with taurodontia, such as cautious examination, sufficient irrigation regimens, and suitable obturation techniques. By reporting these examples and providing insights into the effective diagnosis and treatment strategies for this tooth anomaly, the study seeks to advance our knowledge of the endodontic care of taurodontism.

Case Presentation

Case 1

A 24-year-old systemically healthy male patient was referred to the endodontic department of the University of Mashhad Medical Sciences by his general dentist, who was unable to complete the root canal treatment of the left maxillary first molar due to its complex anatomy. In clinical examination, a temporized tooth was observed, which was unresponsive to pulp/periapical tests. The preoperative radiograph showed a taurodontic anatomy (Figure 1A). Also, a CBCT scan was taken for accurate diagnosis and treatment planning (Figures 1B-1D). In accordance with the Shifman and Chanannel classification, the tooth was classified as Hypertaurodontic (TI≈50) [20]. The patient was scheduled for a non-surgical root canal retreatment following the detection of asymptomatic apical periodontitis from prior treatment. After a local anesthesia infiltration with 2% lidocaine and epinephrine1:100,000 (Daroupakhsh, Tehran, Iran), a rubber dam was used to isolate the tooth. Also, a high-speed diamond round bur No. 2 (Jota AG, Rüthi, Switzerland) was used to reopen the access cavity. Meanwhile, continuous water spray was applied under a

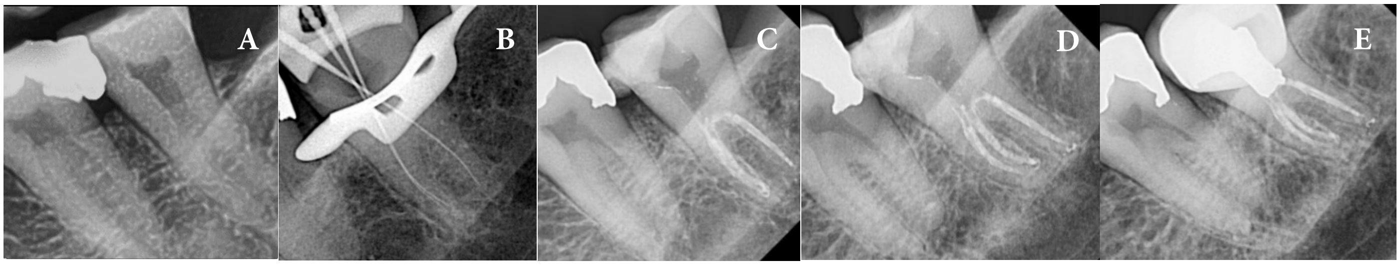

Figure 2. *A*) A preoperative radiograph; *B*) A radiograph with K-file confirming the root canal working length; *C*) A postoperative radiograph taken after root canal treatment and tooth temporization; *D*) A postoperative radiograph taken after root canal treatment and tooth temporization with distal shift; *E*) A 12-month follow-up radiograph

dental operating microscope (Carl Zeiss, Meditec, Dublin, CA, USA). The orifices were negotiated with #8 and #10 K-files (Mani, Utsunomiya, Japan). Working length was determined as 18 mm for the mesiobuccal, 22 mm distobuccal, and 22 mm palatal canals by an electronic apex locator (Dempex, DEM Ltd., Barnstaple, Devon, England), respectively, and confirmed with radiography (Figure 1E). Chemomechanical cleaning and shaping was completed by crown-down technique with M3 rotary files (UDG, Changzhou, China) up to size of 25/0.04 under copious irrigation with 5.25% sodium hypochlorite (NaOCl) and normal saline, alternately. After taking cone-fitting confirmation radiograph (Figure 1F), all canals were dried with sterile paper points (META, Chugbuk, South Korea) and obturated with gutta-percha (META, Chugbuk, South Korea) and AH-Plus sealer (Dentsply DeTrey, Konstanz, Germany) using warm vertical technique by FastFill warm obturator (Fast Fill Obturation System, Eighteeth, China). Finally, Cavit (Cavisol, Tehran, Iran) was applied as a temporary restoration (Figure 1G), and the patient was referred to his dentist for permanent restoration. A follow-up visit was conducted 12 months later. The patient reported no pain or discomfort. The patient had no symptoms either clinically or radiographically (Figure 1H).

Case 2

A 67-year-old male patient was referred for endodontic treatment of the right mandibular third molar. The patient's medical history was non-contributory. The preoperative radiograph showed hypertaurodontic anatomy (TI≈50) (Figure 2A). Then, the patient was scheduled for a non-surgical endodontic treatment following the detection of irreversible pulpitis and asymptomatic apical periodontitis. After mandibular nerve block with 4% Articaine and epinephrine 1:200,000 (Daroupakhsh, Tehran, Iran). The whole treatment process was undertaken under isolation with a rubber dam and a dental operating microscope (Zumax Medical Co., Suzhou New District, China). The orifices were negotiated with #8 and #10 K-files. Working length was determined by an electronic apex locator, which was confirmed radiographically (Figure 2B). Cleaning/shaping were completed by crown-down technique with M3 rotary files up to a size of 25/0.04 under active copious irrigation with ultrasonic 5.25% NaOCl and normal saline, alternately. All obturation procedures and techniques were performed as described for the first case. Finally, Cavit was applied as a temporary restoration (Figures 2C and 2D). For a permanent restoration, the patient was referred to the Department of Aesthetic and Restorative. A follow-up visit was conducted 12 months later. Both clinically and radiographically, the patient had no symptoms (Figure 1E).

Case 3

A 32-year-old systemically healthy male patient was referred to the endodontic department of the University of Mashhad Medical Sciences with a chief complaint of pain on chewing in the left posterior region of the mandible. In clinical examination, a restored left mandibular second premolar with defective margins, which was tender on percussion and palpation, was observed. The preoperative radiograph showed a hypertaurodontic anatomy (TI≈50) (Figures 3A and 3B). The patient was scheduled for a non-surgical endodontic treatment following the detection of chronic irreversible pulpitis and chronic apical periodontitis from prior treatment. After mandibular nerve block with 2% lidocaine and epinephrine 1:100,000, the orifices were negotiated with #8 and #10 K-files. Working length was determined by an electronic apex locator, which was confirmed radiographically (Figure 3C). Chemomechanical preparation of all three canals was performed similarly to that described in previous cases. After taking cone-fitting confirmation radiograph (Figure 3D), obturation of the canals was performed using warm vertical compaction technique similar to that described in previous cases.. Finally, Cavit was applied as a temporary restoration (Figure 3E), and the patient was referred to the Department of Esthetics and Restorative for a permanent restoration. A follow-up visit was conducted 12 months later. Both clinically and radiographically, the patient had no symptoms (Figures 3F and 3G).

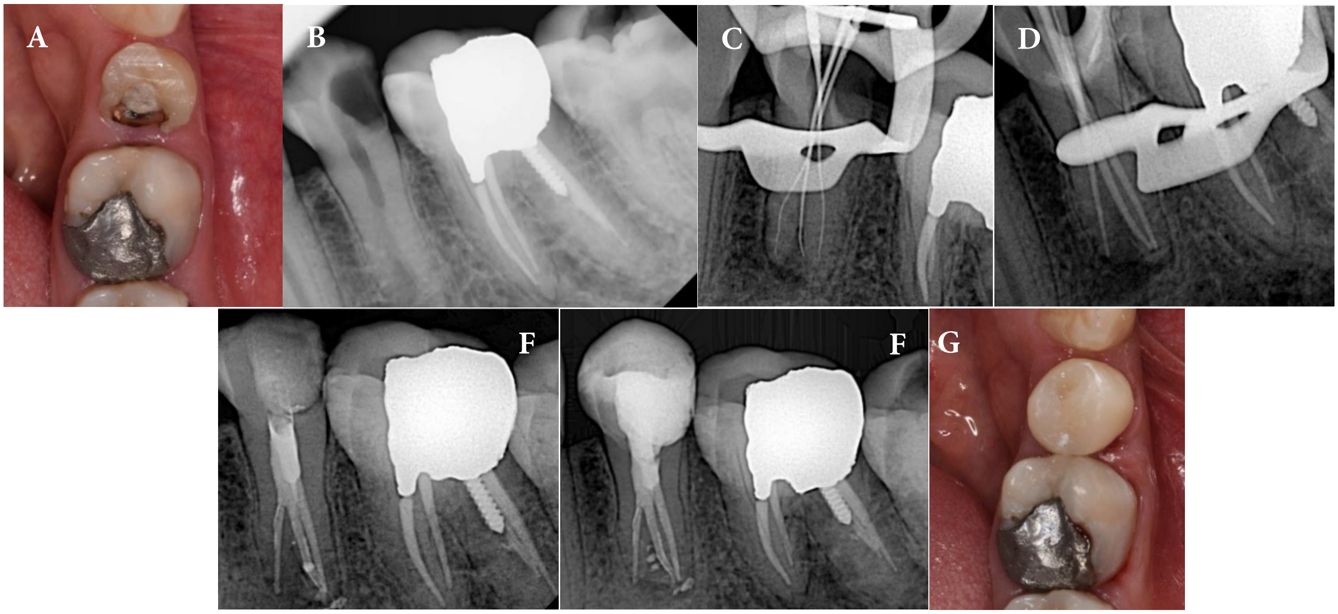

Figure 3. *A*) A preoperative clinical photo; *B*) A preoperative radiograph; *C*) A radiograph with K-file confirming the root canals working length; *D*) A master-cone fit confirmation radiograph; *E*) A postoperative radiograph taken after root canal treatment and tooth temporization; *F*) A 12-month follow-up radiograph; *G*) A 12-month follow-up clinical picture

Discussion

Once believed to be uncommon in modern-day populations, taurodontism is a dental abnormality that is distinguished by a larger pulp chamber and an apically displaced pulp chamber floor. However, several studies across diverse ethnic groups have revealed a wide prevalence range of 0.1% to 21.7% [27-30]. Individuals with particular genetic or developmental problems have a greater occurrence of taurodontism [31-34], often manifesting as multiple taurodonts [16, 35]. Interestingly, a high number of taurodonts has been reported in individuals without systemic syndromes [20 ,19]. The present report documents a case series of three taurodonts in three patients with no known syndromes.

There may be a connection between hypodontia tooth agenesis and taurodontism. Kim *et al.* [36] found that 64 individuals out of 1032 pediatric dental records with panoramic radiographs had at least one tooth agenesis, pointing to a potential connection between these two disorders. Furthermore, Shifman and Channanel [37] discovered that the mandibular second molar, which accounted for almost two-thirds of all cases studied, was the tooth most susceptible . In the current study, two patients exhibited molar taurodontism, while one patient had premolar taurodontism.

Cone-beam computed tomography played a crucial role in the identification and classification of taurodontism, as well as in the evaluation of root canal anatomy [38-40]. The broad field-of-view CBCT imaging system, i-CAT, was shown to be beneficial in evaluating the root canal anatomy of several taurodonts in a single instance. However, its volume is restricted. When assessing an individual tooth, it is advisable to use CBCT imaging to enhance the clarity of its anatomical features [41]. In case No. 1, a CBCT was performed to improve the diagnosis and predict the anatomy.

Because of their extremely varied form, taurodonts provide a number of restrictions for endodontic care [20]. Big pulp chamber, large orifices, and thick pulpal tissue, all of which might cause significant bleeding during access preparation and limit the clinician's vision. The American Association of Endodontists (AAE) states that root canal therapy for teeth with taurodontia is deemed to be very challenging [2, 19, 42]. The possibility of correlated anomalies related to Hertwigs epithelial root sheaths abnormalities (*e.g.*, c-shaped root canal configurations and extra roots root canals) increases with probable causes of taurodontism, including failure of Hertwigs epithelial root sheath invagination [43, 44]. This condition makes the endodontic management of taurodontic teeth much more difficult. Instrumentation is frequently mentioned as the most difficult phase of root canal therapy for taurodonts [45]. Only the tip of endodontic instruments contacts the canal walls due to the small root canals and deep root canal orifice placement. This poor instrument engagement causes inadequate cleaning, shaping, and obturation, thereby affecting the efficacy of the treatment over time. Utilizing magnification lights and doing a thorough examination of the pulp chamber floor with a DG-16 explorer while performing troughing dyes and champagne tests might facilitate the identification of the orifices [45, 46]. In this regard, it is advised to use a 2.5% NaOCl solution to dissolve any remaining pulp tissues effectively [47, 48]. Moreover, copious irrigation with NaOCl, combined with ultrasonic activation, not only aids in the extirpation of bulky pulpal tissue in the chamber but also enhances the intricate root canal system's cleaning procedure system [49]. These operations are particularly effective when accompanied by anomalies such as c-type anatomy when the dentin walls are thin. Therefore, emphasis should be placed on debridement with cautious active irrigation using NaOCl rather than excessive mechanical instrumentation to avoid complications like strip perforations or other procedural accidents caused by aggressive shaping [50, 51]. In this particular instance, the pulp chamber was thoroughly flushed with abundant 5.25% NaOCl and normal saline solution. When creating straight-line access, it is advisable to remove just a small amount of cervical dentin around the canal orifices, particularly in individuals with hypertaurodonts, while using high magnification. In this research, a dental operating microscope (Zumax Medical, Suzhou New District, China) was used to improve visualization and facilitate operations, hence enhancing the three-dimensional filling of the challenging root canal system.

Thermomechanical obturation procedures are recommended in taurodontic teeth [52]. Proper restoration with an appropriate coronal seal after warm vertical compaction can improve treatment outcomes. Additionally, the literature suggests avoiding post-placement during tooth restoration in taurodontic cases [53]. Taurodontic teeth have a decreased ability to bear normal chewing forces because they take up less space in the jawbone, which might affect their stability [54].

Conclusion

The size, form, and degree of obliteration, as well as the complex structure of the canals, vary significantly in teeth with taurodontism. Considering restricted canal openings and the potential for more root canal treatments, significant attention should be paid to exploring canal complexities using tools for enlargement. For the treatment of such teeth, ultrasonic irrigation and an upgraded filling procedure are recommended. Taurodontism is a significant difficulty in the field of endodontics. Utilizing modern diagnostic methods such as CBCT may facilitate the management of difficult circumstances by providing a more comprehensive knowledge of the diverse root canal anatomy.

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Conflict of interest

None.

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Authors' contributions

Conceptualization: AC/MZ; Methodology: AC; Formal Analysis and Investigation: AC; Writing-Original draft preparation: PS/PS/SZJ; Writing-review and editing: PS/MZ/PS/SZJ; Supervision: AC/MZ. All authors read and approved the final manuscript.

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