Paramolar tubercle: A diversity in canal configuration identified with the aid of spiral computed tomography

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ABSTRACT
The objective of this article is to increase our understanding of the root canal system of the anomalous structures like paramolar tubercles. The knowledge of the internal anatomy of the paramolar tubercles is very important as they influence the treatment modalities and associated problems in many dental disciplines. This case report investigates the anatomical and morphological characteristics of a rare case of two well-developed lobulated cusps occurring on the buccal surface of maxillary right second molar with the aid of spiral computed tomography. Unlike to previous reports, in our case the tubercles had their own pulp chamber with its root fused to the mesiobuccal and distobuccal roots of maxillary right second molar, while its canal remained independent from the main root canals. (Eur J Dent 2013;7:139-144)

Key word: Extra cusp; maxillary molar; paramolar tubercle; parastyle; protostylid

INTRODUCTION
Human teeth may show large variations in their morphological features and forms. Such changes may be found in the crown either in the form of anomalous cusps, or in an increased number of roots, which in some instances are associated with an anomalous cusp. The term “paramolar tubercle” has been applied to any stylar anomalous cusp, supernumerary inclusion or eminence occurring on the buccal surfaces of both upper and lower premolars and molars.¹ This was first described in the literature by Late Prof. L. Bolk² of the Anatomical Institute of the University of Amsterdam in the year 1916.

Dahlberg³ in 1945 introduced paleontologic nomenclature when he referred to this structure as “parastyle” when present in the upper molars and as “protostylid” when present in the lower molars. Parastyle may occur in both deciduous and permanent molars and are usually expressed on the buccal surface of the mesiobuccal cusp (paracone) of the upper molars. In rare instances, it is expressed on the distobuccal cusp (metacone) of the upper molars and the buccal surfaces of the upper premolars. Similarly, a double cusp formation is extremely rare.⁴

With respect to size and shape, paramolar tubercles vary; the structure can be anything from a mere prominence of the buccal surface, separated

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from the rest of the tooth by a fossa or a groove, to a well-developed lobulated cusp, separated by a constriction and having the appearance of a fused supernumerary tooth. The lobulated tubercle is often associated with a root that is either rudimentary or fully formed. It is not always necessary that these tubercles contain pulp tissue. In cases where it is strongly pronounced this may be presumed.

Root canals in tubercles are often connected with other canals; in other cases, they are isolated. Over the years, many authors have dealt with the problems of supernumerary features of molars. Their studies have mainly been restricted to their external morphology only without giving consideration to the internal anatomy of these superstructures. Periapical radiographs have been of little significance in assessing the internal structure of the paramolar tubercle as it superimposes on the normal anatomy of the tooth. In these areas, spiral computed tomography (SCT) or volume acquisition CT has proved to be a useful diagnostic tool.

This article reports a rare case of two well-developed lobulated cusps occurring on the buccal surface of maxillary second molar (tooth # 2) that was examined through the use of SCT to ascertain the structure of the tubercles, including the root canal morphology and their relationship with associated tooth roots. Also in this article the etiology and the relevance of this structure with respect to different disciplines of dentistry has also been discussed.

CASE REPORT

A 36-year-old male patient reported to the Department of Conservative Dentistry and Endodontic with a chief complaint of decayed teeth. The patient’s familial and medical history was noncontributory. On clinical examination, in addition to carious teeth, two well-developed lobulated tubercles were found on the buccal surface of tooth # 2 (Figure 1A and 1B). The tubercles exhibited asymmetrical prominence; the mesial tubercles was less pronounced than the distal, while both being more or less expressed on the buccal surface of the mesiobuccal cusp of tooth # 2.

The tubercles were cone shaped and were clearly delineated from each other and the associated tooth by a semilunar trench with a groove. The triangular prominence had their base below the gingival margin while their apexes were oriented occlusally but well below the occlusal plane. The buccal aspect of the tubercles was smooth and featureless, descending straight to the cementoenamel junction. Gingival recession was observed on the buccal surface due to the projection of the tubercles from the tooth and the alveolus (Figure 1B).

After obtaining an informed consent from the patient, investigations were carried out to study the internal structure of the tubercles and its relation with the associated tooth. Periapical radiograph was of little benefit; it showed an additional conical tooth like structure superimposed on the mid-surface of the associated tooth. Though it was not possible to confirm the presence of pulp chamber or root in the paramolar tubercle, but we could clearly demarcate the enamel overlying the tubercle (Figure 2A).

A multislice SCT (Sensation 64, Siemens Medical Solution, Forchheim, Germany) scan of the maxilla was performed with a tube voltage 120kV and a tube current of 390 mA. The involved tooth was focused, and the morphology was obtained in transverse, axial, and sagittal sections of 0.5-mm thickness at 0.5-mm intervals. Axial scans were obtained parallel to the occlusal plane from the level of the maxillary tooth crown to its root apices. These images were processed and evaluated on a separate workstation (Siemens Medical Solution, Forchheim, Germany). The serial cross-sectional images from the SCT scan provided valuable information regarding the canal morphology.

SCT scan images revealed a single and a distinct pulp chamber in paramolar tubercles (Figure 2B). The tubercles had fully formed root that was fused with the mesiobuccal and distobuccal roots of the tooth # 2 along its entire root length. Though the roots were fused, we could still demarcate the individual roots by following the constrictions between the convexities of the root outline at different levels. The root canal was larger in diameter than the mesiobuccal and distobuccal root canals. In shape, the canal was almost-round to oval. To accommodate the tubercle and the additional root, the buccal alveolar bone level was seen more apical at the tubercle (Figure 3A-3C).

DISCUSSION

To understand the etiology of the paramolar tubercles, one need to look into the events that fol-
lows during the formation of the dental cusps. Developmentally, dental cusps begin their formation during the early bell stage, well before calcification of the tooth has begun. The cells of the inner enamel epithelium proliferate and produce activators and inhibitors while they are being deposited in sequential layers from the cusp apex toward the neck of the crown starting from an enamel knot. Enamel knots are sites of nondividing cells that occur in the stellate reticulum as projections from the inner enamel epithelium. The activator produces a primary enamel knot until the concentration reaches a threshold that induces an inhibitor that neutralizes the activator. Enamel knots have been recognized for over a century, though their function was unknown. Recent work by molecular biologists has shown that primary enamel knots produce substances that promote mitotic growth in the adjacent inner enamel epithelium. Since the knots themselves are nondividing, this creates irregularities in the inner enamel epithelium and secondary enamel knots appear. Research demonstrates that the primary enamel knot, which is the earliest to form, configures the oc-

Figure 1. (A) Clinical image showing paramolar tubercles on the buccal surface of tooth #2; (B) facial view of the maxillary study model showing paramolar tubercles. Note gingival recession (arrow) due to the projection of the tubercles from the tooth and the alveolus.

Figure 2. (A) Periapical radiograph showing paramolar tubercle (arrow) superimposed on the mid-surface of the associated tooth; (B) axial SCT scan image of maxilla showing pulp chamber of tooth #2.

Figure 3. Axial SCT scan images of A) cervical, B) middle, and C) apical third sections of the roots of tooth #2.
clusal table of premolars and molars, while later-forming secondary enamel knots individually constitute the cusps during amelogenesis.\textsuperscript{14}

Separate enamel knots seem to coincide with separate centers of enamel formation since amelogenesis invariably progresses gingivally.\textsuperscript{15} Paramolar tubercle seems to arise during the mor-phogenesis process starting from an accessory enamel knot developed at the surface where the feature’s apex forms. Furthermore, findings support the hypothesis that most characteristics of tooth shape and pattern can be altered by modulating the signal pathways, organized into complex networks, mediating epithelial-mesenchymal interactions in developing teeth.\textsuperscript{16}

The occurrence of paramolar tubercle is relatively uncommon. They usually present unilaterally in the permanent dentition. The occurrence of this structure is very low in upper first molars (0% to 0.1%) as compared with upper second molars (0.4% to 2.8%) or upper third molars (0% to 4.7%) in all the given populations.\textsuperscript{4,17-19}

Paramolar tubercles have long been recognized as nonmetric dental traits which are the structural characteristics expressed within certain biological and geographical affiliations. Ethnic and racial background may play an important role in its occurrence. Though there is very little information about racial differences in the frequencies of paramolar tubercles, primarily because of their low occurrence, none the less they should not be classified as anomalous structure since they are normal morphological features of the dentition. For example, paramolars are reported to be infrequent among Africans, Europeans, and their descendants in America, while in a group of native Americans from the southwest (Pima) paramolars are much more common.\textsuperscript{1} Similarly, no cusp formation was observed among whites, Negroses, Filipinos, and Hawaiians. While as Southwestern Indians showed a higher occurrence in both deciduous and permanent molars compared with other populations.\textsuperscript{4}

Due to its low prevalence there is limited information available about the anatomical and morphological characteristics of these tubercles or its relation with the pulp chamber and root canals of the tooth with which it is associated. Bolk\textsuperscript{2} reported that paramolar tubercles in maxillary molars tended to possess their own roots. He also stated that a paramolar tubercle was always united with the anterior buccal cusp of the molar and its roots were attached to mesiobuccal roots. In addition, he even reported that the paramolar root was often present without the tubercle in lower molars.

Kustaloglu\textsuperscript{4} suggested that if the paramolar cusp was large, it might be associated with a separate root. However, it is cannot be said with certainty that all well lobulated tubercles have their own canals while non lobulated tubercles don’t. Thompson\textsuperscript{20} reported a case of root canal therapy of maxillary left second molar with a large extra cusp attached with the distobuccal cusp. In this tooth the extra cusp and the distobuccal cusp of a maxillary second molar had widely separated canals orifices but a shared root canal space. While as, Friedman et al\textsuperscript{6} treated a maxillary molar that had a projection fused to the mesiobuccal cusp, with an additional canal in the fused root near the mesiobuccal canal. Zidan and El-Deeb\textsuperscript{7} reported a case where in the paramolar structure associated with a lower molar was treated with endodontic and restorative means as the canal of the anomalous tooth root was isolated from the main root canal system. Ballal et al\textsuperscript{21} reported a case of endodontic management of unilateral fused mandibular second molar with a paramolar with the aid of SCT. The images revealed that the mandibular left second molar had 3 root canals and that there was continuity between the root canals of the paramolar and mesiobuccal root canal of the second molar. This continuity started 2mm below the cement-enamel junction and was extending throughout the length of the mesiobuccal root. The root length of the paramolar was noted to be 2 mm beyond the mesial root length of the molar.

Ohishi et al\textsuperscript{22} examined the root anatomy of 3 cases with paramolar tuberoles in maxillary second molar with computed tomography. In all the three cases the root of the paramolar tubercle was united with the distobuccal root. All had their own pulp chamber and canals were combined with the distobuccal canal at various levels. In shape, the canals were almost-round to depressed-round; the shape resembled the outline form of the roots. Unlike to previous reports, in our case the tubercles had its own pulp chamber with its root fused to the mesiobuccal and distobuccal roots.
while its root canal remained independent from the main root canals. This discrepancy between our findings and previous reports suggests the need for further research into the root anatomy of paramolar tubercles.

The paramolar tubercles are clinically relevant as they influence the treatment modalities and associated problems in many dental disciplines. The existence of a tubercle and an additional root canal presents a special problem in endodontic therapy. When pulp is present in a paramolar tubercle, the relationship between the pulp of the tubercle and that of the tooth must be determined. When the canal of the tubercle is connected with the main canals then both should be treated at the same time.20–22

These superstructures are potent sites for plaque retention as maintenance of oral hygiene in these areas is difficult and recurrence of dental caries, gingival inflammation, and localized periodontitis is more often possible. The grooves that separated the tubercles from the teeth may extend onto the root surfaces to various depths resulting in vertical bone loss along the groove. In addition, as observed in our case, a tubercle that projects from the tooth or the alveolus may sometimes coincide with recession of the gingiva, a lowered buccal alveolar bone level, or both, leading to deterioration of the surrounding periodontal health.22

During orthodontic treatment, paramolar tubercles interfere with cementation of the brackets and correct alignment of orthodontic archwires and often necessitates it’s removed by ameloplasty. These tubercles even pose problem in the preparation of a tooth for the setting of an artificial crown.23

CONCLUSION

Understanding from the facts discussed above, we can conclude that these tubercles exhibit a diverse canal configuration and each case should be investigated properly prior to commencing any treatment. The knowledge of their internal anatomy is not only important when such teeth require endodontic treatment but also it influences alteration in the treatment modalities within various other disciplines of dental practice.

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