

Unusual occlusal morphology of mandibular first permanent molar: A case report

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The occlusal surface of the mandibular first permanent molar commonly presents a five-cusped or a four-cusped pattern with the occlusal grooves forming a Y shape or a + shape. What follows is a report of two cases presenting an unusual occlusal groove pattern. (Int Chin J Dent 2003; 3: 1-6.)

Key Words: occlusal surface, molar, morphology.

Introduction

The mandibular first permanent molar is situated sixth from the midline of the mandible and is normally the largest mandibular tooth. The occlusal surface of the tooth presents a roughly oblong outline with the mesial and distal surfaces converging toward the lingual surface. There are five cusps - two lingual (the mesiolingual and the distolingual) and three buccal (the mesiobuccal, the distobuccal and the distal). The mesiolingual cusp is the largest cusp and the distal cusp or the *hypoconulus* is the smallest (Fig. 1).

Several variations have been reported in the number and location of cusps in the mandibular first permanent molar.

1. There may be four cusps instead of five because of reduction of the distal cusp giving a more circular outline similar to that of the second permanent molar.¹ The four-cusp type has only one buccal groove.
2. An accessory cusp or paramolar cusp may sometimes be seen on the buccal surface of the mesiobuccal cusp, about in the middle third of the crown. Studies have shown this to occur frequently in the Prima Indians of Arizona² and in Indian (Asian) populations.^{3,4}
3. The distal cusp is often placed lingually in Mongoloids. It may also be split into two parts by a fissure.⁵
4. Some mandibular first permanent molars have a sixth cusp which is named *tuberculum septum* when located on the distal ridge between the distal cusp and distolingual cusp and *tuberculum intermedium* when located between the two lingual cusps.⁶ The sixth cusp is common in the Chinese population.

In 90% of cases, the mesiolingual cusp is joined to the distobuccal cusp across the floor of the central fossa. This feature and the five-cusped pattern is termed as the *dryopithecus* pattern and is characteristic of

all the lower molars of the anthropoid apes and their early ancestors, the dryopithecines. Because of the Y-shaped fissure pattern and the five cusps, the *dryopithecus* pattern is sometimes referred to as a Y5 pattern. In 10% of cases where the mesiobuccal and distolingual cusps meet, a more cruciate system of fissures is produced. This is sometimes referred to as a +5 pattern.⁷ The principal grooves of the mandibular first permanent molar are the central, lingual, mesiobuccal and the distobuccal grooves. The distobuccal groove is unique to this tooth.

The pattern of the grooves on the occlusal surface of the mandibular first molars shows considerable variation. Three principal types of occlusal groove patterns have been described: type Y, in which the central groove forms a Y figure with the lingual groove; type +, in which the central groove forms a + figure with the buccal and lingual grooves (common in four-cusp type of molars); and type X, in which the occlusal grooves are somewhat in the form of an X.⁸

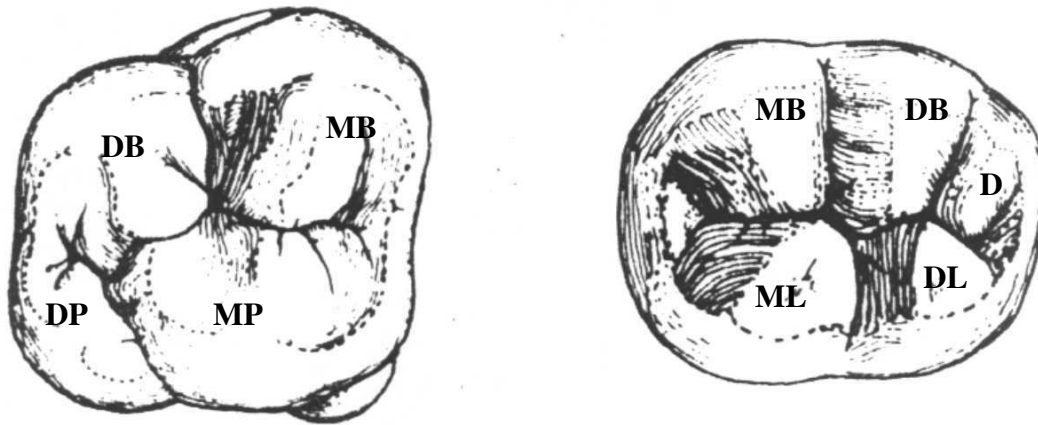


Fig. 1. Occlusal morphology of maxillary and mandibular first permanent molars. Modified from van Beek GC, 1983.¹

The Role of Genetics in Tooth Morphogenesis

Mutations of MSX and DLX genes in humans are associated with specific syndromes, such as tooth agenesis, craniosynostosis, and tricho-dento-osseous syndrome. Davideau et al.⁹ investigated MSX-2, DLX-5 and DLX-7 expression patterns and compared them in orofacial tissues of 7.5-to-9-week-old human embryos by using in-situ hybridization. The expression of MSX-2 in the enamel knot well as the coincident expression of MSX-2, DLX-5, and DLX-7 in a restricted vestibular area of dental epithelium, suggested the existence of various organizing centers involved in the control of human tooth morphogenesis.

The development of individual teeth involves epithelial-mesenchymal interactions that are mediated by signals shared with other organs. The successional determination of tooth region, tooth type, tooth crown base and individual cusps involves signals that regulate tissue growth and differentiation. Tooth type

appears to be determined by epithelial signals and to involve differential activation of homeobox genes in the mesenchyme. This differential signaling could have allowed the evolutionary divergence of tooth shapes among the four tooth types. The advancing tooth morphogenesis is punctuated by transient signaling centers in the epithelium corresponding to the initiation of tooth buds, tooth crowns and individual cusps.¹⁰

Several members of the Fibroblast Growth Factor family i.e., FGF-4, -8, and -9 have been implicated as epithelial signals regulating mesenchymal gene expression and cell proliferation during tooth initiation and later during epithelial folding morphogenesis and the establishment of tooth shape. Kettunen et al.¹¹ analyzed the roles of FGF-3, FGF-7, and FGF-10 in developing mouse teeth. Their results suggested that FGF-3 and FGF-10 have redundant functions as mesenchymal signals regulating epithelial morphogenesis of the tooth and that their expressions appeared to be differentially regulated. In addition, FGF-3 may participate in signaling functions of the primary enamel knot.

It is suggested that the shape and diversity of the mammalian molar teeth is regulated by the primary and secondary enamel knots, which are putative epithelial signaling centers of the tooth. Spatiotemporal induction of the secondary enamel knot determines the cusp patterns of the individual teeth and is likely to involve repeated activation and inhibition of signaling as suggested for patterning of other epithelial organs.¹⁰ Loes, et al.¹² analyzed mRNA expression of Slit-1, -2, -3, earlier characterized as secreted signals needed for axonal pathfinding and their two receptors Robo-1 and -2 (Roundabout-1 and -2) in the developing mouse first molar. Their results indicated that Slits and Robos display distinct, developmentally regulated expression patterns during tooth morphogenesis.

Presented here is a report of two cases displaying a somewhat unusual occlusal pattern of the mandibular first molar hitherto unreported in the literature.

Case Report

Two patients, one, a male aged 12 years (Case 1) and the other, a female aged 9 years (Case 2) reported separately on different days to the Department of Pedodontics and Preventive Dentistry, College of Dental Surgery, Mangalore, for routine checkup. The two patients were not related to one another in any way. Both patients were asymptomatic and healthy with no relevant medical history. The medical histories of both sets of parents were not contributory.

Routine oral examinations of both patients were carried out. Case 1 had minimal plaque and dental caries whereas Case 2 had a healthy and well-aligned dentition with minimal plaque. In Case 1, the mandibular first permanent molar had four cusps (Fig. 2a). In Case 2, the mandibular first permanent molar showed the presence of five cusps, with the distal cusp located on the distal marginal ridge between the two lingual cusps (Fig. 3a). An interesting finding was the presence of a rather unusual occlusal groove pattern in the mandibular first permanent molars of both patients. The occlusal surface showed the presence of two grooves, a mesiobuccal and a distolingual groove with no central groove connecting the two. A well-developed oblique ridge was seen extending between the mesiolingual and the distobuccal cusps (Fig.

2a and 3a), giving the tooth the appearance of a maxillary permanent molar (Fig. 1).

Intraoral periapical radiographs of the permanent first molars in both patients revealed the presence of two roots with normal morphology in all the teeth (Fig. 1b and 2b). The families of both patients were examined for similar findings, but the first permanent molars of all the members examined displayed the common five- or four-cusped patterns with Y-shaped or +-shaped fissures.

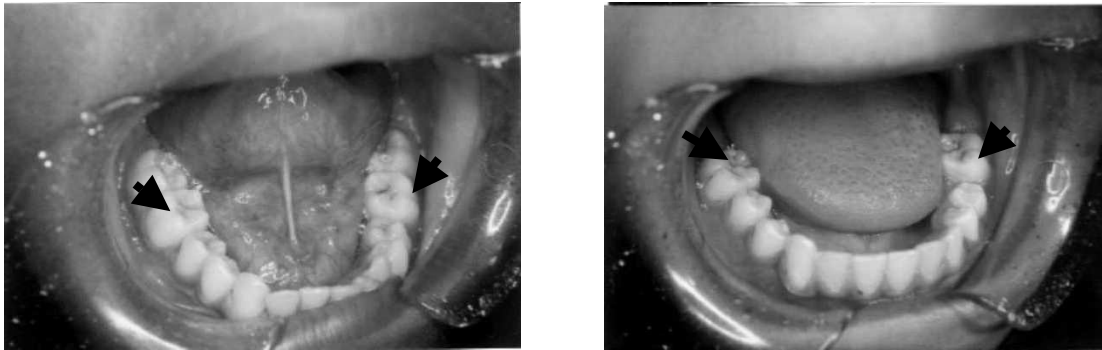


Fig. 2a. Mandibular first molar with four cusps and unusual occlusal groove pattern (left).

Fig. 3a. Mandibular first molar with five cusps and unusual occlusal groove pattern (right).

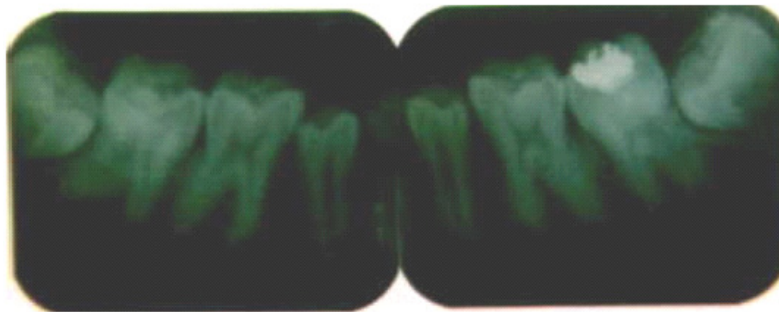


Fig. 2b. Intraoral periapical radiographs of Case 1 showing normal root morphology.

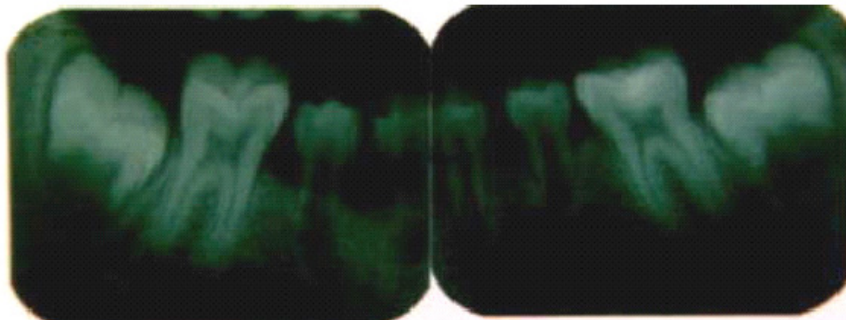


Fig. 3b. Intraoral periapical radiographs of Case 2 showing normal root morphology.

Discussion

Primate molar shapes reflect developmental and ecological processes. Development may constrain as well as facilitate evolution of new tooth shapes. Much of the genetic machinery of development uses the same genes among different organs, including teeth, limbs and feathers. Furthermore, within a tooth, the development of individual cusps repeatedly uses the same set of developmental genes, forming a "developmental module". The repeated activation of the developmental module can explain the cumulative variation in later-developing cusps. Therefore short later-developing cusps may be evolvable but also more homoplastic. This patterning cascade mode of cusp development can be used to explain the variational properties of dental characters and character states related to cusp initiation.¹³

The developmental basis and variational properties of crown termination, cusp shape, and cusp configuration characters are currently less well understood. It is unlikely that there is a simple "gene to phenotype" map for dental characters. Rather, the whole cusp pattern is a product of a dynamic developmental programme manifested in the activation of the developmental modules.¹³

The mandibular first permanent molar normally has five cusps. As a variation, a four-cusped pattern or a six-cusped pattern may also be seen. Three types of occlusal groove patterns are common: the type Y, the type + and the type X. In this case report, two cases have been described in which the mandibular first permanent molar presents a new occlusal groove pattern hitherto unreported in the dental literature.

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ICJD Book News**Finite Element Analysis in Implant Dentistry**

Professor J.P. Geng, the Chair for ICJD and Professor N. Krishnamurthy, one of world greatest scientists in finite element engineering, have written an interesting and relevant book on the use of finite element models in implant dentistry.

I believe that this book will be a welcome addition to the literature on application of mechanical models to implant dentistry. It will be useful not only to research academicians, but also to implantists and prosthodontists who have responsibility for implant clinical work.

Nancy Tan, Executive Editor, World Scientific

Preface

There are situations in clinical reality when it would be beneficial to be able to use a structural and functional prosthesis to compensate for a congenital or acquired defect that cannot be replaced by biologic material.

Mechanical stability of the connection between material and biology is a prerequisite for successful rehabilitation with the expectation of life long function without major problems.

Based on Professor Skalak's theoretical deductions of elastic deformation at /of the interface between a screw shaped element of pure titanium at the sub cellular level the procedure of osseointegration was experimentally and clinically developed and evaluated in the early nineteen-sixties.

More than four decades of clinical testing has ascertained the predictability of this treatment modality, provided the basic requirements on precision in components and procedures were respected and patients continuously followed.

The functional combination of a piece of metal with the human body and its immuno-biologic control mechanism is in itself an apparent impossibility.

Within the carefully identified limits of biologic acceptability it can however be applied both in the cranio-maxillofacial skeletal as well as in long bones.

This book provides an important contribution to clinical safety when bone anchored prostheses are used because it explains the mechanism and safety margins of transfer of load at the interface with emphasis on the actual clinical anatomical situation. This makes it particularly useful for the creative clinician and unique in its field. It should also initiates some critical thinking among hard ware producers who might sometimes underestimate the short distance between function and failure when changes in clinical devices or procedures are too abruptly introduced.

An additional value of this book is that it emphasises the necessity of respect for what happens at the functional interaction at the interface between molecular biology and technology based on critical scientific exploration and deduction.

P-I Brånemark
