A Catalogue of Anomalies and Traits of the Primary Dentition of Southern Chinese

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Variation in size, form and morphology of the teeth result in anomalies such as macrodontia, microdontia, hyperdontia, hypodontia, double tooth, taurodontism and dens in dente. While traits that may occur more commonly in certain ethnic groups may be considered to be specific to that population. The characteristics of these anomalies and traits are presented along with the prevalence figures for their occurrence in primary dentition of southern Chinese.
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INTRODUCTION

Developmental morphological variations of the dentition are frequently observed during a routine dental examination. These include variation of number, size and form. Such variations are of interest in anthrolopology,[1] genetics, pathology and forensic dentistry.[2] Nevertheless, it is in the discipline of Pediatric Dentistry that there is a need to diagnose and ultimately to provide treatment for these variations and their associated pathology.

When a variant occurs rarely in a given racial group, then it is referred to as an anomaly, whereas when the same variant is exhibited by a significant number of people in another population, it is considered to be a trait for the dentition of that population. Although a variety of environmental factors may influence the phenotypic expression of tooth size and morphology, traits of the human dentition have been shown to be under definite genetic control.[3-5]

Studies have reported the prevalence of morphological and numerical anomalies in various ethnic groups.[6,7] Although the Chinese race comprises a quarter of the world's population, little research has been performed on the Chinese dentition. However, published research work has indicated that there are differences in the peoples of northern and southern China.[8]

To document realistic communication between investigators and to ensure accurate and consistent recording of data, the various characteristics and diagnostic features of these anomalies and traits need to be determined. Ultimately, this will enhance the clinical management of a child who presents with a particular anomaly.

To facilitate this process, the essential characteristics of the commonly occurring anomalies, traits and their prevalence in the primary dentition of the Southern Chinese will be presented followed by pictorial representations that exhibit that anomaly or trait.

METHODS AND MATERIALS

The prevalence data of anomalies and traits are based on plaster casts and standardized panoramic radiographs (General Electric Company, U.S.A.) of the primary dentition of 936 children, which had been obtained from a randomly selected sample of 5 years old Hong Kong children**.** A standard anterior occlusal radiograph was taken as a supplementary film for subjects who were suspected of having hyperdontia, macrodotia or *dens in dente*.

CHARACTERISTICS OF ANOMALIES

1. Microdontia

The teeth are smaller than normal and than their antimeres by more than 1mm. There are three types of microdontia: true generalized microdontia, relative generalized microdontia, both of which affect the entire dentition and thirdly, localized microdontia which involves only a single tooth.[9]

True generalized microdontia, in which all the teeth are smaller in size than normal is extremely rare. In relative generalized microdontia, normal or slightly smaller than normal teeth are present in jaws that are larger than normal, thus giv-

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ing an illusion of microdontia. Localized microdontia is rarer in the primary dentition than the permanent dentition.[9]

In this study, microdontia occured more frequently in the maxillary teeth than the mandibular teeth and the canines were the most affected teeth (Figure 1). The prevalence of microdontia in southern Chinese children was 6.3%. When this prevalence figure is compared with other studies,[10-11] it appears that microdontia of the primary maxillary canine is one of the characteristics of the Chinese population.

2. Macrodontia

Macrodontia is also referred to as megalodontia, megadontia and gigantism.[12] It occurs when a tooth or teeth are larger than those considered to be within normal range; that is, they are outside the usual limits of variation. For practical purpose this is a tooth that is 1 mm larger than their antimere or the mean dimension of the tooth, and exhibits normal crown, root and pulp morphology.[13] A larger tooth with the presence of incisal notching, labial or palatal grooving, or supplemented by radiographic evidence of a separated or fused pulp chamber or root was identified as a double tooth instead in this study. Macrodontia can be classified as true generalized, relative generalized and localized macrodontia in a manner similar to microdontia.[9]

True generalized macrodontia is a condition in which all or at least multiple teeth are larger than normal.[9] Relative generalized macrodontia is the result of the presence of normal or slightly larger than normal teeth in relatively small jaws, the disparity giving an illusion of macrodontia.[14-16] Localized macrodontia is when a tooth is larger than normal in size (Figure 2). It is occasionally seen in cases of hemihypertrophy of the face, in which teeth of the involved side may be larger than those of the unaffected side. In the southern Chinese children, macrodontia was observed frequently in the mandibular incisors and canines, and the prevalence of macrodontia was 1.1%.

Double tooth

This anomaly is also known as fusion,[17] gemination,[18] connation,[18] linking tooth,[19] syodontia[20] and dichotomy.[21] It is used to describe any tooth-like structure resembling two complete or partially complete teeth. Hitchen and Morris[18] defined fusion as a result of the embryological persistence of the dental lamina between the two tooth buds, while Kelly[22] considered the same anomaly to be the result of an unsuccessful attempt of two tooth buds to fuse into one. If it occurs early in odontogenesis, the two developing teeth will unite to form a single tooth of almost normal size while if it occurs late in odontogenesis, one tooth, which can be as much as twice the size of the normal tooth, or a tooth with a bifid crown can result.[9] Moreover, fused teeth might have one or two pulp chambers.[23] If the affected tooth is counted as one, there is usually one tooth less than normal for a given dental age.[24] Fused teeth commonly exhibit labial and lingual vertical grooves on the crown surface. These grooves are pronounced in cases of incomplete fusion. Since these grooves are difficult to clean, caries may result. Placement of a sealant or composite material into these grooves decreases the caries risk.[25]

Gemination is the formation of two teeth from the same follicle[26] and there is one common pulp chamber.[22] In gemination, the normal number of teeth is usually present for a given dental age, but one is geminated.[24] It is extremely difficult, if not impossible to distinguish between fusion and gemination. The normal number of teeth present in the mouth is of little or no assistance as fusion may occur between a normal tooth and a supernumerary tooth or between two supernumerary teeth. Gemination may occur in a tooth germ adjacent to a congenitally absent tooth and this would be indistinguishable clinically from fusion.[27] Because a double tooth causes aesthetic and functional problems, proper monitoring of occlusal development to prevent midline deviation and abnormal delay of eruption of the permanent successor(s) is important.[28]

The etiology of double tooth may be inheritance, or as a result of a local factor; possibly the tooth germs move

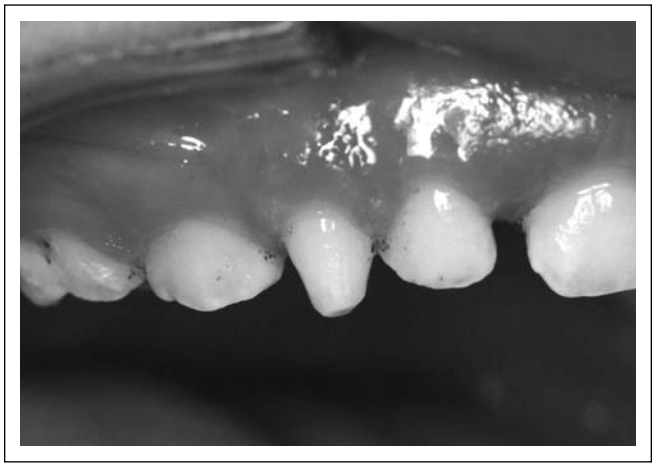

Figure 1. Microdontia of the maxillary right canine.

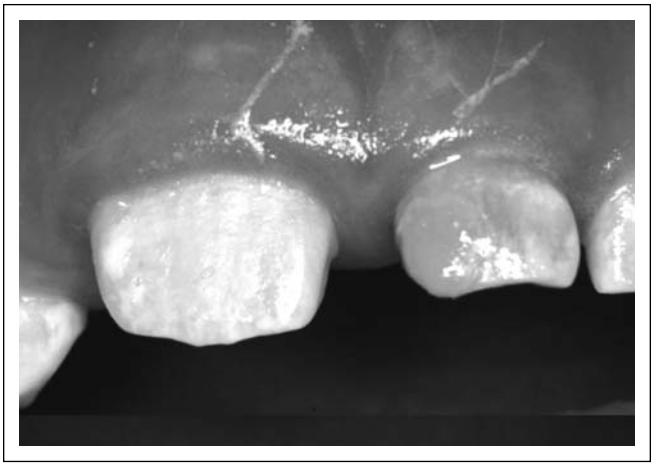

Figure 2. Macrodontia of the mandibular left central incisor. The crown is larger than normal and although the mandibular left lateral incisor is absent, it does not have notching of the incisal edge, or groove on the labial surface. There is a single pulp chamber of the mandibular left central incisor.

Figure 3a. Double tooth involving the maxillary right central and lateral incisor.

Figure 3b. Double tooth involving the mandibular right lateral incisor and canine.

together because of crowding or trauma.[25] The occurrence can be unilateral or bilateral.[29] When bilateral there is a greater likelihood of the subject having anomalies in the permanent dentition. The double tooth anomaly is more common in the primary dentition than the permanent dentition.[30] It is also stated that there may be an inter-relation between primary and permanent double teeth.[31] Also, a macrodont permanent tooth tends to follow a primary double tooth.[32] Double tooth in the primary dentition has been associated with disturbances in the permanent teeth varying from macrodontia, to enlargement of the contralateral tooth, to supernumerary teeth or even missing teeth.[32] It occurs mostly in the anterior region[32,33] and frequently involves the mandibular canines and the lateral incisors followed by the maxillary anterior region.[34] Double primary tooth formation involving two adjacent teeth, especially the central and lateral incisors in the maxillary arch (Figure 3a) or the lateral incisor and canine in the mandibular arch (Figure 3b) is much higher than any other type of double tooth. The prevalence of double tooth in southern Chinese children is 4.1%.

4. Talon cusp

In 1892, Mitchell[35] described it as a "process of horn-like shape" curving from the base to the "cutting edge" on the palatal surfaces of the incisors (Figure 4). Mellor and Ripa proposed the term talon cusp because they considered that the shape of the anomaly resembled an eagle's talon.[36] It has also been referred to as a cusp-like projection,[35] hyperplasia of the cingulum,[37] palatal accessory cusp[38] and unusual projection of the "facial" surface of the anterior teeth.[39] They have a multifactorial etiology combining both genetic and environmental factors.[40] One cause may be hyperactivity of the dental lamina, which occurs most commonly in the anterior region.[41] Talon cusps are morphologically well delineated and extend at least half the distance from the cemento-enamel junction to the incisal edge of the primary teeth. A talon cusp can cause problems with aesthetics, increase the caries suspectibility of the affected tooth, cause occlusal trauma, irritation of the tongue during speech and mastication, displacement of teeth, advanced attrition, leading to pulpal exposure or periapical pathologies.[42] Treatment modalities include gradual, periodic reduction with fluoridation as a desensitising agent, single appointment with or without pulp therapy, sealant for developmental grooves and partial reduction with camouflage.[36,43] Clinically, the cusp extends past the incisal edge of the tooth, blends smoothly with the rest of the tooth, except where it joins the sloping lingual surface of the incisor. At this junction, there is a deep developmental groove. Small talon cusps which are confluent with the lingual surface are less likely to contain pulp tissue while the large separated talon cusps contain pulp tissue.[44] Radiographically, it resembles a radio-opaque v-shaped structure pointing towards the incisal edge of the tooth which is superimposed on the normal image of the crown. It is observed only in the maxillary anterior teeth and involves the incisors and canines.[45] Talon cusps are rare in the primary dentition.[46] with a prevalence in southern Chinese children of 0.5%.

5. *Dens in dente*

This anomaly has also been referred to as warty teeth[47] or invagination of the enamel[48] while Tomes[49] first defined this anomaly as an infolding of the enamel and dentin towards the pulp. He stated that the defective tooth was usually irreg-

Figure 4. Talon cusp on the left maxillary central incisor.

Figure 5a. Dens in dente seen on both of the permanent central incisors.

ular in shape and that the enamel investing the crown could be perfectly developed, but there may be a slight depression in the crown (Figure 5a), the dark center of which represents the blocked orifice of a cavity within the tooth. The epithelial invagination may originate from the crown or the root of the tooth (Figure 5b). It is seen mostly on the palatal surface of the maxillary incisors.[50] The lateral incisors tend to be affected more than the central incisors and the occurrence can be bilateral.[51] There is no prevalence data for dens in dente in southern Chinese children in this study because it did not appear in any of the study population.

6. Taurodontism

A molar tooth in which there is a tendency for the body of the tooth to be enlarged at the expense of the roots is said to exhibit taurodontism.[52] It can be confirmed radiographically as the tooth tends to be more rectangular in shape (Figure 6). The pulp chamber is enlarged, especially vertically and the tooth also lacks the usual cervical constriction.[53] This trait is of interest to anthropologists in the determination of the evolution of man.[54,55] Taurodontism is generally associated with

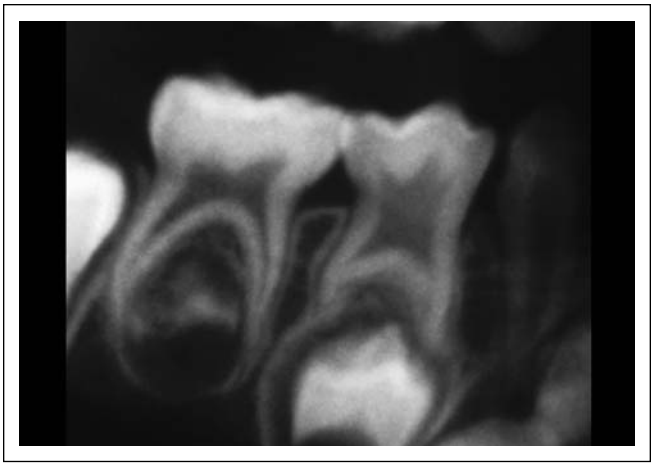

Figure 6. The radiographic appearance of the mandibular right first molar showing taurodontism.

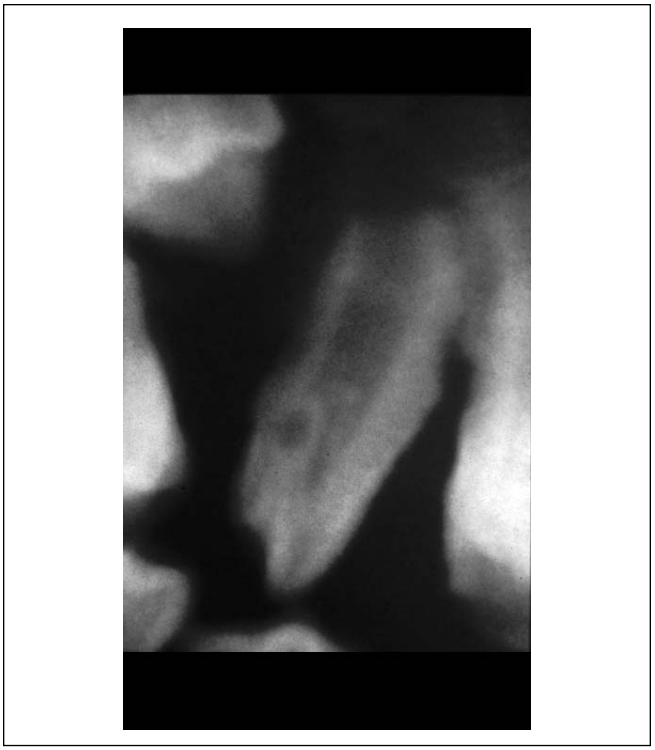

Figure 5b. Dens in dente in a permanent incisor.

the following conditions: ectodermal dysplasia, Down's syndrome, dwarfism[55] and Kleinfelter syndrome.[56] Other anomalies which are coincidental with taurodontism include amelogenesis imperfecta, enamel hypoplasia, oligodontia, microdontia and pulp stones.[57] Since the diagnosis of this trait can only be made reliably from the radiographic examination, the knowledge of the associated conditions may be important when radiographs cannot be obtained.[53] Although this developmental disturbances may not be associated with an increase in caries suspectibility the clinical management may be more complicated. Severe clinical complications can result from the abnormal morphology of a taurodontic tooth when endodontic therapy is indicated because, the extensive length of the pulp chamber may create difficulties in locating the root canals and subsequently, in cleaning and obturation.[58] According to Shaw,[54] taurodontism occurs in varying degrees that can be classified in increasing order of severity as hypotaurodontism, mesotaurodontism and hypertaurodontism. It can occur in both the primary as well as the permanent dentition. It is mostly seen in the posterior region and usually more evident within the mandibular molars.[53] The occurrence can be unilateral or bilateral.[59] Although taurodontism is known to occur in southern Chinese children, no prevalence figure is currently available.

7. Hypodontia

Hypodontia refers to the congenital absence of one or multiple teeth.[9] It is a rare anomaly in the primary dentition. Also known as oligodontia, agenesis of teeth when associated with syndromes or systemic abnormalities, or anodontia when all the teeth are missing.[51] True anodontia refers to the

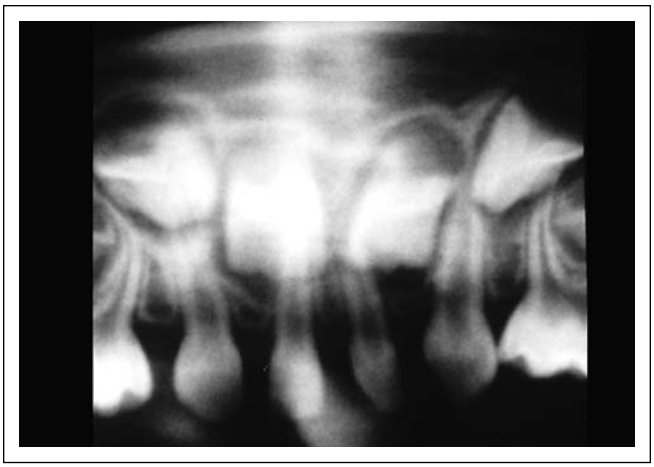

Figure 7a. Radiographic appearance of hypodontia in the maxillary anterior region.

Figure 7b. Hypodontia involving both of the mandibular lateral incisors.

congenital absence of teeth. It has been classified as partial and total.[60] However, partial anodontia is a misnomer. Hypodontia is the favoured term and involves one or more missing teeth. Anodontia is a rare condition which is most often a manifestation of hereditary ectodermal dysplasia.[9] Rarely does this condition occur as an isolated entity.[61] False anodontia is a term sometimes used to describe clinically missing teeth as the result of extractions.[60] Hence, a dental history should be taken to preclude the possibility of previous extractions. It is commonly classified according to the severity of the condition as: (I) mild-to-moderate hypodontia: absence of usually two teeth or more but fewer than six teeth, excluding the third molars, (II) severe hypodontia: absence of six teeth or more, excluding the third molars, and (III) oligodontia: absence of multiple teeth, frequently associated with systemic manifestations.[62-64]

Hypodontia can be due to injury to the developing tooth germ, physical obstruction, disruption of the dental lamina, space limitations, or functional abnormalities of the dental epithelium or mesenchyme.[51] However, some recent studies have emphasised the role of the nerve supply to the development of teeth.[65] Children who have hypodontia in the primary dentition have higher chances of having hypodontia in the permanent dentition.[26,30,66] Hypodontia usually occurs in the anterior region and more frequently in the maxilla than the mandible. Maxillary lateral incisors (Figure 7a) and mandibular incisors (Figure 7b) are the most frequently affected teeth. It is rare for the primary teeth to be missing in both the maxillary and mandibular arches.[26,30,67] In southern Chinese children, the prevalence of hypodontia is 4.1%.

8. Hyperdontia

Hyperdontia, which is considered to be rare in the primary dentition,[68] is one or more normal, or abnormal teeth, for any given type of tooth. They are also referred to as supernumerary, supplemental,[69] paramolars, distomolars and mesiodens.[70] These supernumerary teeth can arise as a result of splitting of the tooth germ,[71] or extra budding of the dental lamina.[72] However, in most cases there is an unknown etiology. Supernumerary teeth which may or may not resemble a tooth of the normal series, may be divided into two types according to shape; "supplemental" refers to a tooth that resembles a normal tooth, while "rudimentary" defines dysmorphic teeth of abnormal shape but smaller in size.[73] Supernumerary teeth in the primary dentition exhibit less variation in shape than those in the permanent dentition[74] and supernumerary primary teeth are frequently followed by permanent supernumerary teeth.[26,30,75] They are more prevalent in the permanent dentition than the primary dentition.[68] In the lateral incisor region, they are usually normal in form whereas in the central incisor area, they tend to be peg-shaped[26] (Figure 8) and rarely remain unerupted.[67] The complications often associated with unerupted supernumerary teeth are: enlarged follicular sacs, nasal eruption and cystic degeneration.[73,74] Supernumerary teeth in the maxillary anterior region can also cause a variety of pathological disturbances to the developing dentition such as over retention of the primary teeth, delayed eruption of the permanent teeth, bodily displacement, rotation, impaction, diastema, root resorption and loss of vitality.[73-76]

When any of the above complications occur, surgical removal of the supernumerary tooth is indicated to induce

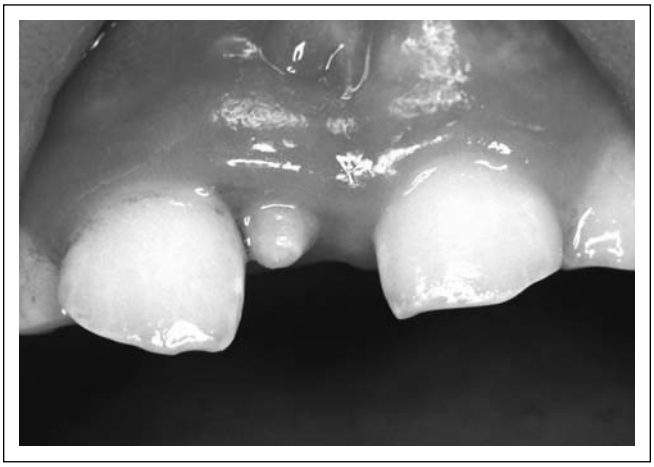

Figure 8. A supernumerary tooth (mesiodens) erupting between the maxillary central incisors.

Figure 9. Shovelling on the maxillary incisors.

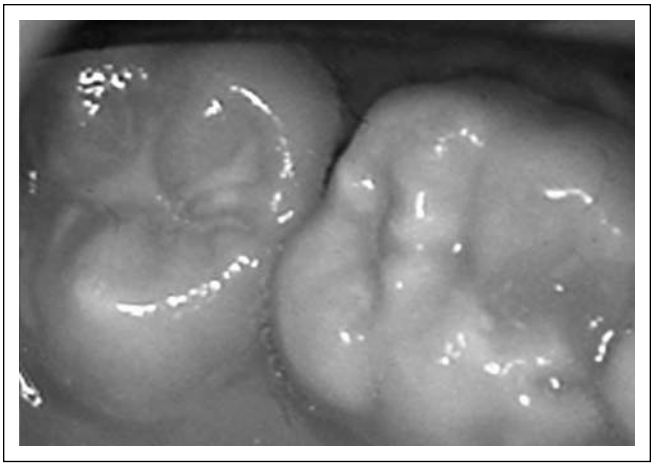

Figure 10. Carabelli's cusp on the palatal aspect of the maxillary right second molar.

spontaneous eruption of the permanent teeth, prevent anterior space loss, midline shift and extensive surgical or orthodontic treatment.[73,77,78] In this study all of the supernumerary teeth that were identified had erupted. The extra tooth can be single or multiple, unilaterally or bilaterally located. Hyperdontia in the primary dentition shows a predilection for the premaxillary region.[27,67] It is seen more in the maxilla than the mandible.[9,67,73] However, supernumerary teeth have been reported to be seen in widely differing areas such as the nose, the orbit, antrum and even in the ovary.[67] In southern Chinese children, the prevalence of hyperdontia is 2.8%.

CHARACTERISTICS OF TRAITS

Shovelling

This trait is present when the palatal surface of an incisor resembles a shovel due to the combination of a concave lingual surface in association with elevated marginal ridges. The four degrees of shovelling are: no shovelling, a trace of shovelling, semi-shovelling and shovelling.[79] Shovelling is more common in the permanent dentition than the primary dentition.[79,80] It is more frequently observed in the maxillary incisors than mandibular incisors.[1] and the lateral incisors are affected more than the central incisors (Figure 9). The prevalence of shovelling in southern Chinese children is 98.0%.

Carabelli's cusp

This is an additional cusp on the mesiolingual surface of the crown of a maxillary molar. This cusp is found to have a variable expressivity such as lobular, cuspoid, ridged and pitted.[81] Morphologically, it varies from an indented surface (ridges and pits) to a full cusp. In the primary dentition, it is located on the lingual surface of the protocone of the maxillary second molar in the form of tubercle (Figure 10) or a slight depression.[82] The prevalence in southern Chinese children is 80.3%.

Protostylid

Protostylid is an additional cusp on the buccal cusp of a molar (Figure 11a). It is also known as a paramolar tubercle or Bolk's cusp.[83] Jorgensen[84] described the two types of paramolar tubercle formation as: a "welt", in which the eminence is limited by a groove but it lacks a free tip, and a

Figure 11a. Protostylid on the mesiobuccal cusp of the mandibular right first molar.

Figure 11b. Protostylid on the mesiobuccal cusp of the maxillary left second molar.

"cusp", in which the eminence is more developed and its tip is free i.e. the tip extends higher occlusally than the furrow by which it is separated from the buccal surface. This trait occurs more often in the primary dentition than the permanent dentition.[85] When the protostylid is present on a permanent molar, the trait is usually also present in the primary molar; however, the reverse situation does not always occur.[85,86] The second molars are the most frequently affected teeth (Figure 11b). In southern Chinese children, the prevalence of protostylid is high at 91.7%.

CONCLUSIONS

Most anomalies on primary teeth occur in the anterior region.[30,32] Some of the anomalies for instance, shovelling, Carabelli's cusp, and protostylid are characteristics (traits) and not anomalies of the southern Chinese children. Thus, if a clinician is able to appreciate the nature and implications of such anomalies and traits that are peculiar to a racial group, he/she would be in a better position to prescribe the most appropriate course of management. Such information is especially important to dentists working with children who, due to their racial group, have a high prediction for some of these features in their dentitions.

REFERENCES

1. Grine FE. Anthropological aspects of the deciduous teeth of South African blacks. Johanesburg Witwatersrand University Press; 1986.
2. Whittington BR, Durward CS. Survey of anomalies in the primary teeth and their correlation with the permanent dentition. New Zealand Dent J, 92: 4–8, 1996.
3. Bowden, Goose DH. Inheritance of tooth size in Liverpool families. J Med Genet, 6: 55–58, 1969.
4. Goose DH, Lee GTR. The mode of inheritance of Carabelli's trait. Human Biology, 43: 64–69, 1971.
5. Dahlberg AA, Kirveskan, Dahlberg T. The Pima Indian studies of inheritance of dental morphological traits. In Kurtin, B.(ed). Teeth: form, function and evolution. New York: Columbia University Press, 292–297, 1982.
6. Dahlberg AA. The dentition of the American Indian in Laughin, W.S.(ed), Papers on the physical anthropology of American Indian, New York: Viking Fund, 1949: 138–176, 1949.
7. Hanihara K. Studies on the deciduous dentition of the Japanese and the Japanese-American hybrids. 1. Deciduous incisors. J Anthropol Soc Nippon, 63: 168–185, 1954.
8. Meacham W. On the ethno-linguistic identity of the ancient Yeuh. Symposium on evolution of Yueh (Cantonese) people and languages: qualitative and quantitative approach. Hong Kong; 1993.
9. Shafer WG, Hine MK, Levy BM. A textbook of oral pathology. Ed 3. Philadelphia, WB Saunder Co, 34–46, 1974.
10. Brook AH. Dental anomalies of number, form and size: their prevalence in British schoolchildren. J Int Assoc Dent Child, 5: 37–53, 1975.
11. Saito T. A genetic study on the degenerative anomalies of deciduous teeth. Jap J Hum Genet, 4: 27–53, 1959.
12. Dugmore CR. Bilateral macrodontia of the mandibular second premolars: a case report. Int Pediatr Dent, 11: 69–73, 2001.
13. Chaudhary SI, Sprawson NJ, Howe L, Nairn RI. Dental twinning. Br Dent J, 182: 185–188, 1997.
14. Groper JN. Macrodontia of a single tooth: review of literature and report of case. J Am Dent Assoc, 114: 69, 1987.
15. Reichart PA, Westergaard J, Jensen KA. Macrodontia of a mandibular premolar. Oral Surg, 44: 606–609, 1977.
16. Scully C, Welburg R. Colour atlas of oral diseases in children and adolescents. London, 64, 1994.
17. Levitas TC. Gemination, fusion, twinning and concresence. J Dent Child, 32: 93–100, 1965.
18. Hitchin AD, Morris I. Geminated odontome –connation of the incisors in the dog-its etiology and ontogeny. J Dent Res, 45: 575–583, 1966.
19. Sprinz R. The linking tooth. Br Dent J, 95: 108–110, 1953.
20. DeJonge TE. Geminate tooth formation. Tschr Tandheek, 62: 828–834, 1955.
21. Schulze G. Development abnormalities of the teeth and jaws. Thoma's oral pathology , ed, 6. St. Louis. The CV Mosby Company, 96–184, 1970.
22. Kelly J. Gemination, fusion or both? Oral Surg Oral Med Oral Pathol, 45: 655–656, 1978.
23. Tannenbaum KA, Alling EE. Anomalous tooth development. Oral Surg Oral Med Oral Pathol, 16: 883–887, 1963.
24. Duncan WK, Helpin ML. Bilateral fusion and gemination: a literature analysis and case report. Oral Surg Oral Med Oral Path, 64: 82–87, 1987.
25. Milano M, Seybold S, McCandless G, Cammarata R. Bilateral fusion of the mandibular primary incisors: report of case. J Dent Child July-August: 280-282, 1999.
26. Ravn JJ. Aplasia, supernumerary teeth and fused teeth in the primary dentition. Scand J Dent Res, 79: 1–6, 1971.
27. Soames JV, Southam JC. Oral pathology. Oxford: Oxford University Press, second edition, 3-7, 1993.
28. Yuen SW, Chan J, Wei SHY. Double primary teeth and their relationship with the permanent successors: a case radiographic study of 376 cases. Pediatr Dent, 9: 42–48, 1987.
29. Kayalibay H, Uzamis M, Akalin M. The treatment of a fusion between the maxillary central incisor and supernumerary tooth: report of a case. J Clin Pediatr Dent, 20: 237–240, 1996.
30. Grahnén H., Granath LE. Numerical variations in primary dentition and their correlation with the permanent dentition. Odont Revoy, 12: 348–357, 1961.
31. Erdem GB, Uzamis M, Ölmez S, Sargon MF. Primary incisor triplication defect. J Dent Child, 68: 322–325, 2001.
32. Brook AH, Winter GBW. Double teeth: a retrospective study of "geminated" and "fused" teeth in children. Br Dent J, 129: 123–130, 1970.
33. Clayton JM. Congenital dental anomalies occurring in 3357 children. J Dent Child, 23: 206–208, 1956.
34. Hagman FT. Anomalies of form and number, fused primary teeth, a correlation of the dentitions. J Dent Child, 55: 359–361, 1988.
35. Mitchell WH. Case report. Dens Cosmos, 34: 1036, 1892.
36. Mellor JK, Ripa LW. Talon cusp: a clinically significant anomaly. Oral Surg Oral Med Oral Pathol, 29: 225–228, 1970.
37. Worth HM. Principles and practice of oral radiologic interpretation. Chicago: Year Book Medical Publishers, 81, 1963.
38. Ooshima T, Ishida R, Mishima K, Sobue S. The prevalence of developmental anomalies of teeth and their association with tooth size in the primary and permanent dentitions of 1650 Japanese children. Int J Paediatr Dent, 6: 87–94, 1996.
39. Jowharji N, Noonan RG, Tylka JA. An unusual case of dental anomaly: a "facial" talon cusp. ASDC J Dent Child, 59: 156–158, 1992.
40. Davis PJ, Brook AH. The presentation of talon cusp: diagnosis, clinical features, associations and possible aetiology. Br Dent J, 160: 84–88, 1986.
41. Rantanen AV. Talon cusp. Oral Surg, 32: 398–400, 1971.
42. Hsu CYS, Girija V, Fei YJ. Bilateral talon cusps in primary teeth: clinical significance and treatment. ASDC J Dent Child, 68: 239–43, 2001.
43. Pitts DL, Hall SH. Talon cusp management: orthodontic–endodontic considerations. ASDC J Dent Child, 50: 364–368, 1983.

44. Mader CL, Kellogg SL. Primary talon cusp. J Dent Child, 223–226, 1985.
45. Mader CL. Talon cusp. J Am Dent Assoc, 103: 244–246, 1981.
46. Liu JF, Chen LR. Talon cusp affecting the primary maxillary central incisors in two sets of female twins: a report of two cases. Pediatr Dent, 17: 362–364, 1995.
47. Salter SJA. Warty tooth. Trans Pathology Soc London, 6: 173–177, 1855.
48. Hallet GEM. The incidence, nature and clinical significance of palatal invaginations in the maxillary incisor teeth. Proc R Soc, Med 46: 491–499, 1953.
49. Tomes J. Description of an inverted tooth and the consequences which its inversion entailed, considered in relation to certain forms of tumours of the jaw. Br Dent J Sc II, 146–148, 1858–1859.
50. Goto T, Kawahara K, Imai K, Kishi K, Fujiki Y. Clinical and radiographic study of dens invaginatus. Oral Surg Oral Med Oral Pathol, 48; 88–91, 1979.
51. Shafer WG, Hine MK, Levy BM. A textbook of oral pathology. Ed4. WB Saunders Co, Philadelphia, London, 37–50, 1983.
52. Keith A. Problem relating to the teeth of earlier forms of prehistoric man. Proc R Soc Med, 6; 103–110, 1913.
53. Ogden G. The significance of taurodontism in dental surgery. Dent Update, 15: 32–34, 1988.
54. Shaw JC. Taurodont teeth in South African cases. J Anat, 62: 476–499, 1928.
55. Jorgensen RJ. The conditions manisfesting taurodontism. Am J Med Genet, 11: 435–442, 1982.
56. Stewart RE. Taurodontism in x-chromosome aneuploid syndromes. Clin Genet, 6: 341–344, 1974.
57. Ogden G. Taurodontism in dermatologic disease. Int J Dermatol, 27: 360–364, 1988.
58. Seow W, Lai PY. Association of taurodontism with hypodontia: a controlled study. Pediatr Dent, 11: 214–219, 1989.
59. Shaw GR. The significance of taurodontism in dental surgery. Dent Update, 1: 32–34, 1988.
60. Stimson JM, Sivers JE, Hlava GL. Features of oligodontia in three generations. J Clin Pediatr Dent, 21: 269–275, 1997.
61. Burzynski NJ, Escobar VH. Classification and genetics of numeric anomalies of dentition. Birth Defects Orig Artic Ser, 19: 95–106, 1983.
62. Brook AH, Hobkirk JA. The management of patients with severe hypodontia. J Oral Rehabil, 7: 289–298, 1980.
63. Grahnén HJ. Hypodontia in the permanent dentition. Odontol Rev, 7(suppl 3): 77–78, 1956.
64. Shashikiran ND, Karthik V, Subbareddy VV. Multiple congenitally missing primary teeth: report of a case. Pediatr Dent, 24: 149–152, 2002.
65. Kjaer I, Kocsis G, Nodal M, Christensen LR. Aetiological aspects of mandibular tooth agenesis- focusing on the role of nerve, oral mucosa and supporting tissues. European J Orthodontics, 16: 371–375, 1994.
66. Davis PJ, Darvell BW. Congenitally missing permanent mandibular incisors and their association with missing primary teeth in the Southern Chinese (Hong Kong). Commun Dent Oral Epidemiology, 21: 162–164, 1993.
67. Luten JR. The prevalence of supernumerary teeth in primary and mixed dentitions. J Dent Child, 34: 346–353, 1967.
68. Roberts A, Barlow ST, Collard MM, Hunter ML. An unusual distribution of supplemental teeth in the primary dentition. Int J Paediatr Dent, 15: 464–467, 2005.
69. Glassington CW. Supplemental tooth. Br Dental J Sci, 36: 330–332, 1893.
70. Bolk L. The supernumerary upper incisors in man. Deutsche Monatschr P Zahnh, 35: 185–228, 1917.
71. Yusof WZ. Non-syndrome multiple supernumerary teeth: literature review. J Cand Dent Assoc, 56: 147–149, 1990.
72. Huang WH, Tsai TP, Su HL. Mesiodens in the primary dentition stage: a radiographic study. J Dent Child, 59: 186–189, 1992.
73. Primosch RE. Anterior supernumerary teeth-assessment and surgical intervention in children. Pediatr Dent, 3: 204–215, 1981.
74. Taylor GS. Characteristics of supernumerary teeth in primary and permanent dentition. Dent Prac, 22: 203–208, 1972.
75. Gellin ME. The distribution of anomalies of primary anterior teeth and their effect on the permanent successors. Dent Clin North Am, 28: 69–80, 1984.
76. Levine N. The clinical management of supernumerary teeth. J Canad Dent Assoc, 28: 297–303, 1961.
77. Solares R. The complications of late diagnosis of anterior supernumerary teeth: case report. J Dent Child, 57: 209–211, 1990.
78. Brin I, Zilberman Y, Azaz B. The unerupted maxillary central incisor-review of its etiology and treatment. J Dent Child, 49: 352–356, 1982.
79. Hrdlicka A. Shovel shaped teeth. Am J Phys Anthropol, 3: 429–466, 1920.
80. Tratman EK. A comparison of the teeth of people of Indo-European with Mongoloid racial stock. Dent Rec, 70: 31–53, 63–88, 1950.
81. Dietz VH. A common dental morphotropic factor, the Carabelli's trait. J Am Dent Assoc, 31: 784–789, 1944.
82. Hanihara K. Some crown characters of the deciduous incisors and canines in Japanese-American hybrids. J Anthropol Soc Nippon, 72: 1–11, 1965.
83. Bolk L. Welcher Gebissreihe gehrÖren die Molaren an? Zeitschrift fÜr Morphologie una Anthropolosie, 17: 83–116, 1915.
84. Jorgensen RJ. The deciduous dentition: a descriptive and comparative anatomical study. Acta Odontologica Scandinavica, 14(suppl 20): 1–202, 1956.
85. Hanihara K. Criteria for classification of crown characters of the human deciduous dentition. J Anthropol Soc Nippon, 69: 27–45, 1961.
86. Dahlberg AA. The evolutionary significance of the protostylid. Am J Phys Anthropol, 8: 15–25, 1950.