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A study of the connective tissue surrounding the developing tooth in the vervet monkey

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SUMMARY

Developing teeth in the Vervet monkey (Cercopithecus aethiops) were examined at various pre-eruptive stages. A longitudinal arrangement of periodontal fibres was seen grouped alongside the bone and cementum and parallel to them. These fibres later extended coronally, passing around the reduced enamel epithelium. It was difficult to compare this study to other species as there were differences in terminology and in the precise stages of development described. There was however a suggestion that the pre-eruptive periodontal fibre arrangement in the vervet monkey is similar to that in man.

OPSOMMING

Ontwikkelende tande in die blouapie (Cercopithicus aethiops) is op verskillende voor-erupsie stadia ondersoek. Die periodontale vesels is in die lengte gerangskik en teenaan die been en sementum, en parallel met hulle saam gegroepeer. Hierdie vesels het later in die koronale vlak verleng, en het om die verminderde glasuurepiteel gegroei. Dit was nie moontlik om hierdie ondersoek met die van ander spesie te vergelyk nie aangesien beskrywings en terminologie verskil sowel as stadia van ontwikkeling. Daar was egter 'n aanduiding dat die voor-erupsie periodontale veselrangskikking in die blouapie soortgelyk aan die van die mens is.

Non-human primates have been used as experimental models in a variety of studies on periodontal disease, (Levy, 1971; Ammons, Scheckmann and Page, 1972). It has been suggested that for a primate to be used in such studies, the teeth and periodontium should closely resemble that in man (Ammons *et al*, 1972). A metrical study was undertaken by Volchansky and Cleaton-Jones (1973) using the vervet monkey (*Cercopithecus aethiops*), in which a morphological similarity seemed to exist in the relationship between the gingiva and the alveolar bone around the premolar and molar teeth in this animal and man.

These findings have prompted further studies on the vervet monkey periodontium and a continued investigation of the suitability of this animal as an experimental model for periodontal research is being undertaken.

Studies on collagen fibre arrangement around the developing teeth in both man and experimental animals, have mainly been conducted in association with studies on tooth eruption. The connective tissue surrounding the molar teeth in the Cyomologous monkey (*Macaca irus cuv*) was described by Magnusson (1968). The pre-eruptive teeth were surrounded by a loose vertical network of fibres resembling those in the dental sac, and from a thin layer of cementum on the roots a dense rim of short fibres was present. These fibres gradually lengthened horizontally or slightly coronally and intermingled and joined with vertical fibres.

In the Rhesus monkey, Glenwright (1970) searched for the circular collagen fibres described by Arnim and Hagerman (1953) in man. He found a distinct band of fibres which persisted throughout eruption, coronal to the erupting incisor teeth. Glenwright termed these longitudinal gingival fibres, and considered them different from the circular fibres of Arnim and Hagerman, in man. Levy and Bernick (1968), using conventional terminology, described four groups of fibres present during development and organisation of the periodontal ligament of deciduous teeth in the marmoset monkey. These were termed free gingival fibres, alveolar crest fibres, horizontal and oblique fibres.

In further studies on the development of deciduous and permanent teeth in the marmoset, Grant and Bernick (1972) and Grant *et al* (1972), described fibres arising from firstly the cementum, and shortly thereafter from bone. These fibres radiated out into the periodontal space to form an intermediate plexus which persisted until the onset of function.

The fibre arrangement during tooth development in man has been described by Sicher (1972). He stated that the periodontal ligament was derived from the dental sac which envelops the developing tooth germ. Three groups of fibres were noted around the tooth germ. There was an outer group of fibres related to the bone, an inner group of fibres adjacent to the tooth, and an intermediate zone of unorientated fibres between the other two.

This investigation was undertaken to study and describe the connective tissue surrounding the molar and premolar vervet monkey teeth, and compare it with that occurring in other primates and man.

MATERIALS AND METHODS

The specimens were obtained from vervet monkeys in the mixed dentition stage of development and consisted of pre-eruptive premolars and molars. They were removed together in a single block of mandibular bone and fixed in 10% buffered formol saline, then decalcified in 5% formic acid, and serial paraffin sections 7 μm thick were cut in the buccolingual plane in

some sections and in the mesio-distal plane in others. Sections were stained with either haematoxylin and eosin or Pacini's stain (Romeis 1948).

The ages of the animals from which specimens were obtained for this study differed and could not be accurately determined as the animals were obtained from a wild population group. As the specimens were selected from animals in the mixed dentition stage of development, a good cross section of the stages of permanent tooth development was present in the sample studied.

This study encompassed tooth development from the formation of the dental follicle through the stages of development prior to tooth eruption in premolar and molar teeth.

The connective tissue surrounding the developing teeth were studied around the apical area, mid-root area, the area of the reduced enamel epithelium and the coronal area of pre-eruptive teeth.

RESULTS

Pre-eruptive developing tooth

The development and orientation of the connective tissue surrounding the developing teeth was studied in four regions in the pre-eruptive teeth (Fig. 1.)

i) *Apical regions*

The connective tissue adjacent to the apex of the tooth consisted of fine groups of fibres running coronally parallel to the root between the cementum and the bone. Fibre orientation was such that only slight intermingling occurred in the intermediate area. At this stage there was no visible evidence of fibres running from the root to the surrounding bone (Fig. 2).

ii) *Mid-root region*

The fibres lying between cementum and the adjacent bone were consolidated into a dense fibrous band which formed a central fibrous core, which was joined by numerous short fibres arising from cementum. At this stage of tooth development there was no sign of fibres transversing the longitudinal fibre or occupying the periodontal space (Fig. 3).

iii) *Amelo-cemental junction region*

The longitudinal fibre group continued parallel to the reduced enamel epithelium and was joined by a band of fibres arising from the cementum at the amelo-cemental junction (Fig. 4).

iv) *Coronal region*

In the coronal area the reduced enamel epithelium was enclosed in a well-defined band of fibrous connective tissue which was continuous with the fibrous elements arising from the apical and mid-root longitudinal fibres. This connective tissue consisted of a dense well-defined parallel fibre arrangement, lying between reduced enamel epithelium and overlying bone (Fig. 5).

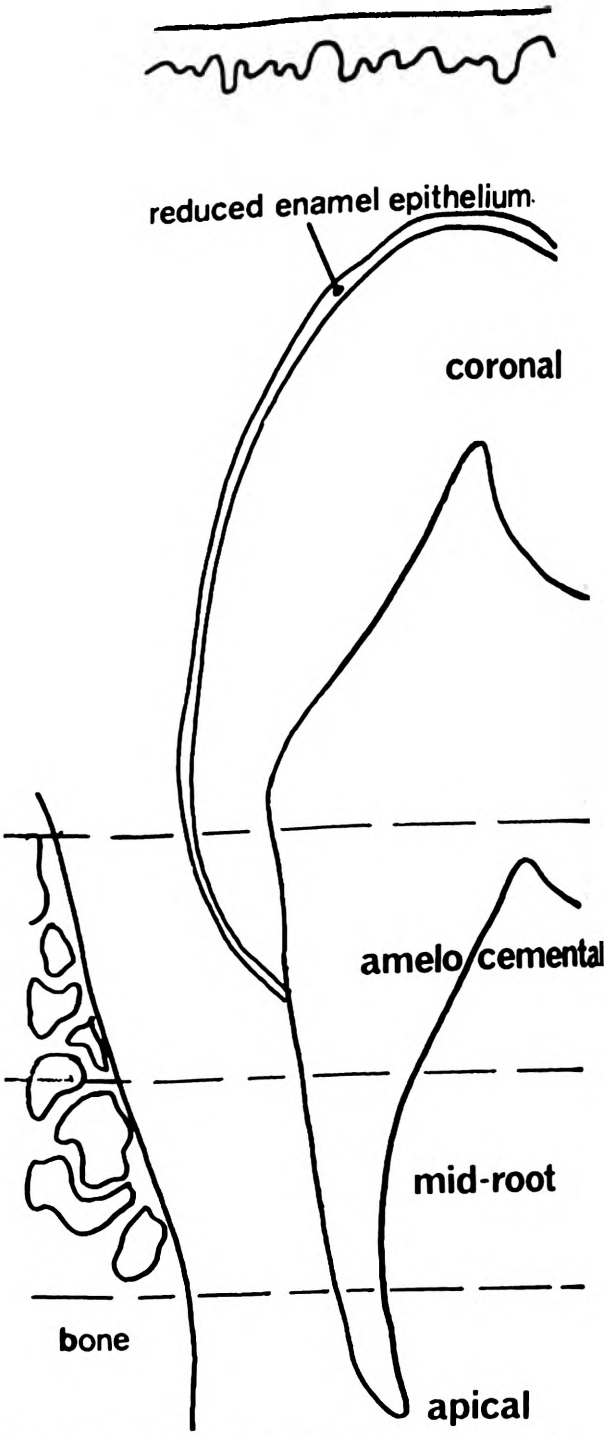


Fig. 1. Diagrams of four regions studied in the pre-eruptive teeth.



Fig. 2. Apical region showing fibres running adjacent to bone (b) and root, d = dentine, with the longitudinal fibre (lf) between the two. Pacini stain x 250.



Fig. 3. Mid-root region where a core of fibres is seen to be joined by short fibres from the root surface. ree = reduced enamel epithelium, es = enamel space. Pacini stain x 250.

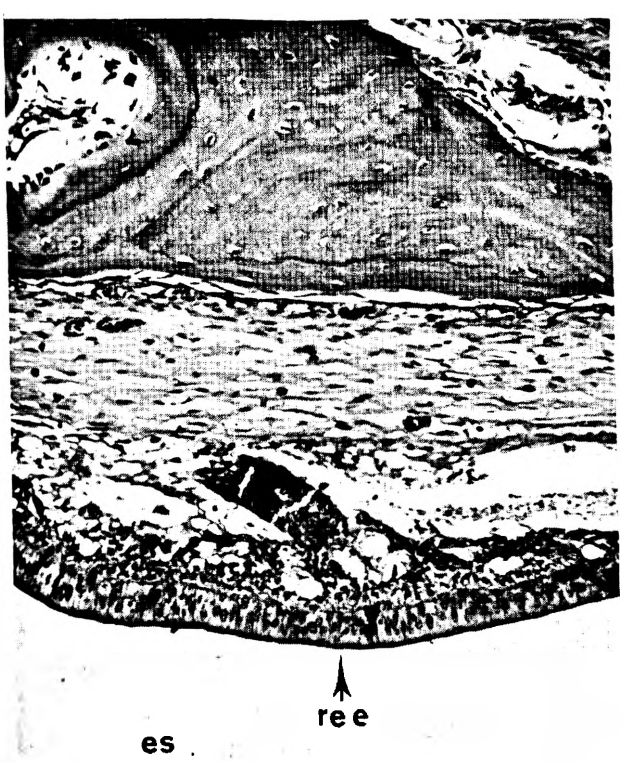


Fig. 5. Coronal region showing the fibres passing between bone and the reduced enamel epithelium (ree). es = enamel space. Haematoxylin and eosin stain x 500.

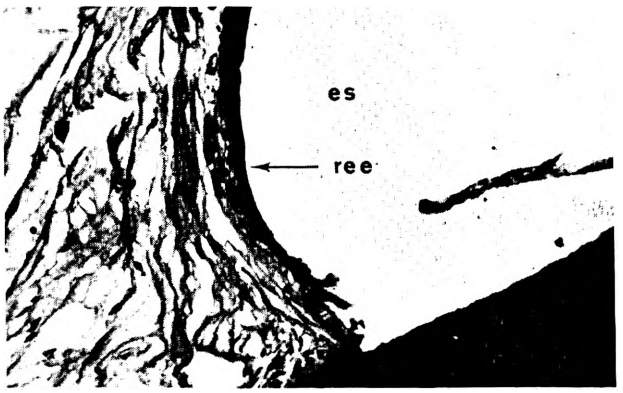


Fig. 4. Amelo-cemental junction region with the longitudinal fibres joined by fibres from the root surface passing alongside the reduced enamel epithelium (ree). es = enamel space. Haematoxylin and eosin x 440.

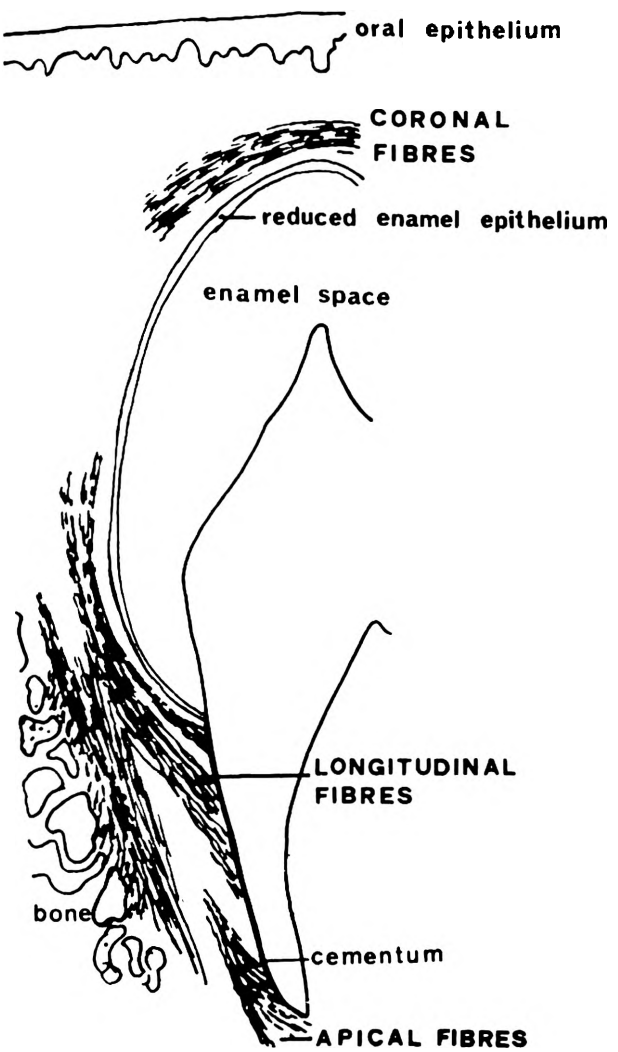


Fig. 6. Composite diagram showing the various regions with a summarised fibre arrangement around the pre-eruptive developing tooth.

DISCUSSION

The findings in the various regions at various stages around the pre-eruptive developing tooth are summarised in the composite diagram shown in figure 6. In this diagram the gaps between the apical longitudinal and coronal fibres are present because of the different stages of development examined. It would not be strictly accurate to join these although it is felt that they are continuous.

It is obvious from the diagram that no fibres were seen passing into the bone from the cementum but fibres from the two linked and intermingled in the intermediate periodontal space as they ran coronally.

It is important to compare these findings with those of the other workers mentioned in the introduction taking into account the differences and the many difficulties encountered. Glenwright (1970) described the incisor region, which has proved to differ from the present study in the molar region. There is a similarity between the findings regarding the longitudinal fibres in the present study and those of Magnussen in the *Macaca irus cuv* molar. He did not mention any coronal fibres.

The fibres described in the present study in the vervet monkey did not however, correspond to those of Levy and Bernick (1968) in the marmoset. Their earliest description of free gingival fibres resembled the longitudinal fibres described here just below the cemento-enamel junction but they did not mention the fibre grouping alongside bone, cementum and those fibres seen between the two groups. Similarly there was no mention of fibres overlying the crown. They concentrated on the incisor teeth but although it is likely that there is a similar situation around the molars this has not yet been demonstrated. Their description was of deciduous teeth but once again there does not seem any reason why in the pre-eruptive stage this should be different to the permanent teeth.

The intermediate plexus described by Grant and Bernick (1972) and Grant *et al* (1972) was not seen in the present study. Possibly the different species and stages of development in their study and mine can explain this absence. It was felt that a greater degree of fibre organisation might have been expected at such a late pre-eruptive stage than they observed.

There is then an obvious confusion over the development of the periodontal membrane in the species mentioned. This may be the result of a lack of standard terminology, different species studied; different situations in the mouth; and different stages of development. All this indicates that more work is needed in the field.

One thing that has emerged from this study is the similarity between the findings in the developing vervet molar and the description of that in man by Sicher (1972). This does suggest that the vervet anatomy in the molar and premolar regions is close to that in man.

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