Experimental Tooth Ankylosis in the Monkey

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Attempts to produce ankylosis of deciduous teeth of monkeys by direct mechanical or chemical injury to the root, or by occlusal trauma, were unsuccessful; but luxation with no other injury did cause ankylosis.

Dental ankylosis is an unusual phenomenon which can occur in both deciduous and permanent teeth. The etiology of dental ankylosis is still poorly understood, although local trauma has been thought to be an important factor.

Textbooks on dental histology[2,3,4,5] agree on the general nature of dental ankylosis and emphasize trauma as an important causative agent. Sicher, in *Orban's Oral Histology and Embryology*,[2] writes that "increased masticatory forces cause resorption of deciduous roots and the repair of the resorbed areas may be excessive, and may even lead to ankylosis between bone and teeth."

Provenza, in *Oral Histology Inheritance and Development*[3] states that "the onslaught of the erupting permanent successor tooth takes its toll of the periodontal membrane," and that "it has been demonstrated that efforts to repair eroded areas stimulate ankylosis." He further states that "Occasionally synostosis of a separated root

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fragment occurs. The fragmentary remains which fail to be resorbed, work their way to the surface of the gingival mucosa and are exfoliated."

Zita[6] suggests the theory of a disharmony in the growth processes, in that the tooth fails to erupt or move occlusally while surrounding tissues continue to develop normally. Biederman[7] hypothesizes a basic metabolic disturbance in the etiology of ankylosis.

Dental ankylosis has been produced experimentally in dogs by electric diathermy[8] and by treatment of the root canals with formalin.[8]

In one experiment, Rubin and Biederman[9] subjected left mandibular deciduous molars of puppies to various injuries of the periodontium, using the lower right quadrant as controls. Openings about 3mm in circumference were made at the middle of the mesial root of the second deciduous molar and the distal root of the first deciduous molar so that the cementum in the interproximal area was lightly involved. In another animal, only the second deciduous molar was traumatized, this time using phenol over a greater area.

Radiographs were taken pre- and postoperatively, and again three or four months later when shedding had been completed. Both the radiographs and clinical examination showed no ankylosis of the experimental teeth, and there was no significant difference in shedding times from the controls. Histological studies were not made.

Parker *et al*[10] demonstrated with radiographs and histological studies on dogs that ankylosis can be produced in some cases by injuring the root and periodontal membrane and then splinting the teeth. He used dental burs to injure the roots, occasionally to the point of devitalization.

The previous studies involved botl permanent and deciduous teeth ii dogs. We felt that a similar exper ment on monkeys, a more closely re lated humanoid species, could be mor applicable to clinical practice. W used deciduous teeth with roots ur dergoing resorption, and simulate the types of trauma which might oc cur in a child's dentition, such as blow to an anterior tooth or excessiv pressure in mastication.

Methods and Materials

Four Cynamoglus monkeys wer used in this study. Experiments wer confined to deciduous incisors and d ciduous molars.

Complete records, including dent casts and lateral jaw and periapic radiographs, were taken at variou time intervals. At the conclusion c the experiments the teeth and su porting bone of the experiment areas were removed surgically in block and histological sections pr pared.

Some of the animals were sacrifice and the alveolar bone with the inta teeth of the nonexperimental ar were fixed, sectioned and stained f use as controls.

The animals were anesthetized wi intraperitoneal nembutal for all pr cedures.

Four experimental methods we used, as described below.

Monkey No. 1
Mechanical Periodontal Trauma

A vertical incision was made fro the gingival crest along the distal ro of the maxillary right first deciduo molar. The periosteum was elevat and the buccal alveolar bone d placed by inserting a surgical gou between root and bone. Part of t periodontal membrane was then i

jured by removing the exposed portion of the membrane with a fine periodontal curette.

Monkey No. 2
Chemical and Surgical Root Trauma

Four weeks after the following procedures, block sections were removed (bone and tooth) and fixed in formalin. Serial sections were stained in hematoxylin and eosin.

Chemical

A vertical gingival incision was made from the crest of the ridge along the distal root of the lower left mandibular first deciduous molar and the gingivae elevated. A small section of bone was removed with a chisel and round bur and the periodontium exposed to chemical trauma in the form of a dab of phenol inserted into the alveolar bone of the injured area. The gingival tissue was then sutured.

Surgical

A #700 bur was inserted interproximally to denude the distal root surface of the lower right second deciduous molar. The tooth was then stabilized with a one-piece gold casting cemented on injured and adjacent teeth, with special care to avoid occlusal trauma.

Monkey No. 3
Occlusal Trauma

The left mandibular second deciduous molar was prepared by slicing the interproximal surfaces, and a stainless steel crown was cemented so that it would contact its antagonist prematurely in occlusion. The monkey was fed a normal diet of monkey chow.

After a two-month interval, the crown was removed. Two weeks were allowed for healing and repair before the animal was sacrificed. A section containing tooth and surrounding tissue was removed and prepared as described in the previous experiment (Fig. 1).

Monkey No. 4
Trauma by Luxation

A maxillary deciduous incisor was luxated with forceps. Luxation is defined as dislodgement without removal of the tooth. The tooth is loosened to a degree where it exhibits mobility in all directions, yet remains in the socket. Periodontal fibers are either severed or severely stretched by this procedure.

After a four-week interval, labial and palatal incisions were made along the distal of both lateral incisors. The periosteum was elevated and a block section was removed, fixed and stained with hematoxylin and eosin.

Results

Histologic studies on the three animals subjected to periodontal trauma, root trauma and hyperocclusion revealed no evidence of ankylosis. The histologic sections revealed classical wound repairs in which new bone was still separated from the root cementum by a thin periodontal membrane.

Fig. 1 Radiograph after 2 months of occlusal trauma (crown).

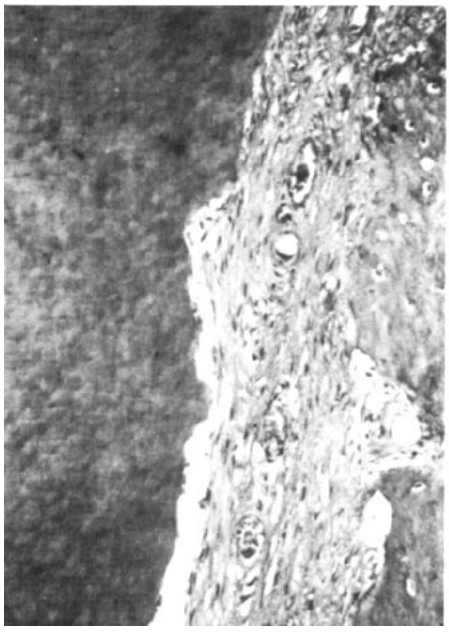

Fig. 2 Bur injury, with scalloping resorption

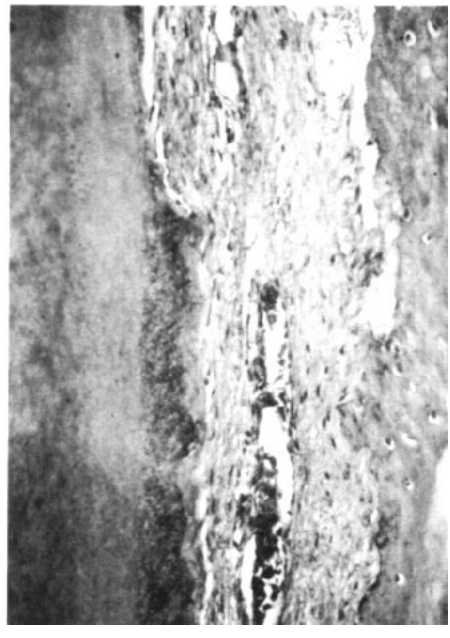

Fig. 4 Ankylosis following luxation.

In the case involving bur injury to the cementum (Monkey No. 2), considerable irregularity occurred in the formation of the cementum, with scalloping resorption (Fig. 2).

Fig. 3 shows an unusual example of healing in which pulpal exposure occurred during the procedure. In this case bone tissue proliferated into the exposed part of the pulp canal, and cementum repair occurred. Periodontal fibers can nevertheless be seen interposed between the osseous tissue and the cementum.

Fig. 3 Pulpal exposure, with bone proliferating into the pulp canal.

Hyperocclusion resulted in a thick and congested periodontal membrane and the resorption of the normal cementum layer, but no ankylosis.

In luxation (Monkey No. 4), histologic evidence of true ankylosis was found. This animal was sacrificed four weeks after the operation. Fig 4 shows a histologic section of the root surface, with compression of the periodontal membrane into an amorphous avascular mass and new bone in apposi-

tion to the cementum layer of the root.

Discussion

A review of the literature suggests that conditions leading to ankylosis most often involve some type of tissue injury.

Parker's work on dogs[10] obviously did not simulate typical trauma, since his experimental procedures inflicted dental bur injuries to the roots and periodontal membrane, often to the point of devitalization.

Although the physiological factors involved in tooth ankylosis are still largely unknown, our work leads us to agree with Biederman,[7] who feels that occlusal trauma is not a predominant etiological factor.

It is most interesting to note that ankylosis may occur at only a microscopic point on the root. This would substantiate a suggestion by Hemley[11] for clinical action—that apparently some ankylosed teeth can be mechanically freed by surgical luxation. If the area of ankylosis is small, the fracture of this fusion and restoration of mobility to the tooth might possibly reverse the process, with due regard to our findings on luxation.

Dougherty's[12] suggestions that "In the future, orthodontic retention of teeth and prevention of relapse may be controlled by injections of sclerosing solutions into the periodontal membrane space, uniting tooth to bone," and that "many ankylosed teeth have lasted a lifetime, even as abutments, with few or no ill effects" cannot be reconciled with the principles of oral physiology and our present understanding of the true physiological nature of dental ankylosis in the total growth picture.

In normal occlusion teeth are constantly erupting along with the growth of alveolar bone, maintaining a dynamic relationship through the life span of the tooth. Intentionally inducing ankylosis for some therapeutic objective would interfere with tooth-to-tooth relationships and also affect occlusal force distribution, total jaw growth patterns and long-term occlusal relationships.

Ankylosis of a tooth is always accompanied by an arrest of both eruption and of the growth of alveolar bone in the affected area.

Other etiological alternatives such as genetic influence or congenital gaps in the periodontal membrane require further investigation. Sharaway *et al*[13] observed multiple ankylosed teeth in a litter of Sprague-Dawley gnotobiotic rats, and suggested genetic factors as the probable etiology.

Summary

In this small study, radiographs and study casts were made of three Cynamoglus monkeys with deciduous dentitions. Roots were traumatized with a chrome-steel crown in hyperocclusion, and by exposing root surfaces surgically and traumatizing with a rotating bur or chemical irritants. Histologic studies revealed scalloping resorption of cementum but no evidence of ankylosis.

However, when a maxillary deciduous incisor was luxated by forceps, block sections taken four weeks after the injury revealed areas of bone in close apposition to cementum.

This last type of injury would seem to be one mechanism for producing dental ankylosis in the monkey.

Conclusions

1. This series of experiments succeeded in producing ankylosis experimentally in vivo only by luxation.

Other more local short-term traumatic agents failed to do so.

2. Since the comparison of radiographic evidence of ankylosis with histologic studies shows poor correlation, the use of x-rays to diagnose ankylosis is questionable. When two levels of occlusion are observed in adjacent teeth, the possibility of ankylosis should be explored.

3. Further studies should be conducted on animals to observe all stages in the production of ankylosis in teeth.

4. Studies should be conducted to learn the effects of certain osteogenic agents, genetic and congenital factors in the causation of ankylosis in the deciduous and permanent dentition.

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