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Tooth Ankylosis And its Orthodontic Implication

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Abstract: *Tooth ankylosis is the union of the tooth root to the alveolar bone, with local elimination of the periodontal ligament. The etiologies of dental ankylosis include trauma, genetic factors, local metabolic anomalies, deficiency of alveolar bone growth, and abnormal pressure of the soft tissues. An ankylosed tooth can lead to serious clinical problems such as vertical alveolar bone loss, midline deviation, tipping of adjacent teeth, impaction of the ankylosed tooth, and supraeruption of the opposing tooth. The diagnosis of ankylosis can be made by both clinical and radiologic evaluations. Clinically, typical metallic sounds upon percussion, lack of tooth mobility, and dental infraocclusion with a higher gingival margin may be observed. Ankylosis should be visible as an interruption of the periodontal membrane space on a radiograph. However, the most important evidence of an ankylosed tooth is the inability of movement during orthodontic force applications. Tooth ankylosis is one of the various problems in dentistry and requires special treatment approaches for satisfactory results. In the orthodontic treatment of an ankylosed tooth, different treatment modalities have been put into practice including both orthodontic and orthodontic-surgical approaches.*

Keywords: *ankylosis, infraocclusion, lack of mobility, osteogenic distraction, radiograph*

I. Introduction

Charles M. Schulz once said there is nothing more attractive than a nice smile. He was absolutely right; for a smile is the key for facial attractiveness. What determines an individual's smile are the "social six" which are the maxillary incisors and canines because they are on maximum display during speech in most individuals. The normal eruption, position and morphology of these teeth are essential for facial esthetics and phonetics. Missing anterior teeth have barely any functional problems with speech difficulties including the 's' sound being the mostly reported. Yet, they have major esthetic effect on self-esteem and general social interaction.

II. Definition

Dentoalveolar ankylosis is an eruption anomaly defined as the fusion of mineralized root surface to the surrounding alveolar bone with obliteration of the periodontal ligament. It may occur during eruption, or before or after emergence of the tooth into the oral cavity. It is most likely to affect a replanted avulsed tooth or a severely intruded tooth.

Ankylosis is considered a "rare disease" by the Office of Rare Diseases of the National Institutes of Health. This means it affects less than 200,000 people in the US population.

Prevalence rates of ankylosed deciduous teeth vary from 1.3% to 14.3% of the population, depending on the criteria used, with a significantly higher incidence between siblings. Family records are helpful since there is a familiar tendency for the disorder. Female to male ratio is 6:5.

Primary mandibular molars are ten times more affected than the primary maxillary molars. The mandibular first primary molar is the tooth most often affected. Other investigators reported the mandibular second deciduous molar is the most frequently involved. The difference is due to the fact that first mandibular deciduous molars ankylose earlier, produce less infraocclusion and usually exfoliate on time, which means that they may go undetected. In contrast, second mandibular primary molars produce more severe infraocclusion and a slight delay in the eruption of their permanent successors. Maxillary primary molars ankylose earlier than mandibular primary molars with usually, worse prognosis.

Caucasians and Hispanics have a greater incidence of ankylosis of deciduous teeth than Blacks and Orientals. Ankylosis of permanent teeth is 10 times less frequently than primary teeth with mandibular and maxillary first molars being most frequently ankylosed followed by maxillary canines and incisors. Multiple teeth ankylosis is as common as single instances, and a patient with one or two ankylosed teeth is likely to have other teeth become ankylosed later. Teeth that become intruded more than 6 mm or half of the clinical crown length within weeks after trauma become more susceptible to being ankylosed.

Certain endocrine conditions and congenital diseases, like cleidocranial dysostosis and ectodermal dysplasia have been linked to a high incidence of tooth ankylosis and the submergence of the involved primary teeth. It may be due to a disturbed metabolism. There are systemic causes of delayed eruption to differentiate it from ankylosis. These include: osteopetrosis, hypopituitarism, hypothyroidism, avitaminosis A and D, fanconis syndrome, vitamin D resistant rickets, mongolism, acrocephalosyndactyly, and epidermolysis bullosa.

Kurol and Magnusson have found that in young children the ankylotic area is often in the apical part of the root, while in older children, it is located more coronally.

Where a permanent successor is present the ankylosed deciduous molar usually resorbs normally and the effects on occlusal development are temporary. Another study showed that it may cause a slight delay in the eruption of the permanent successors. Deciduous molars without a successor had a higher prevalence, and did not exfoliate spontaneously and showed progressive infraocclusion.12

III. Process Of Ankylosis

Ankylosis may lead to local destruction of the periodontal ligament. External replacement resorption is the result of injury to the innermost layer of the periodontal ligament and possibly the cementum. The healing process takes place from the adjacent alveolar bone, causing ankylosis.

IV. Etiology

The causes of ankylosis can be categorized as either genetic predispositions or local metabolic changes. Local reasons include trauma such as luxation injuries, avulsed tooth replantation, deficiency of alveolar bone growth, abnormal pressure of the soft tissue, periapical infections, chemical or thermal irritation, and previous surgical procedures.[8] The majority of dental injuries occur in children aged 6 to 12 years with luxation being the most frequent injury. When a tooth is traumatized in young patients, it fails to erupt along with the remaining alveolar process during vertical facial growth. This results in submerged teeth with defects in the alveolar process. The severity of submersion is proportional to the rate of facial growth.

In cases of replantation of avulsed teeth in growing patients, ankylosis happens during the repair process. The replanted tooth appears impacted because it fails to move during vertical growth of the remaining alveolar process. The extraalveolar time is the factor that affects the prognosis of the replanted tooth. This means immediate replantation decreases negative periodontal ligament outcomes. Inflammatory resorption sustained by bacterial infection of necrotic pulp tissue in the replanted or severely intruded tooth can be effectively arrested by pulpectomy followed by calcium hydroxide root canal filling. However, despite the ability to treat inflammatory resorption predictably, its arrest promotes replacement resorption.

A high incidence of tooth ankylosis has been associated with the presence of a stainless steel ligature at the cementoenamel junction where the wire is positioned. It is believed that this is the least desirable way to place an attachment for the application of orthodontic forces; because it may act as an irritant to the periodontal ligament and results in injury or ankylosis.

V. Sequences And Problems

Eruption is a continuous process and does not stop once the tooth comes into contact with the antagonist. It compensates for jaw growth in young age and for abrasion in older age. A permanent first molar erupts approximately 1cm after it initially reaches the occlusal level and is in function in order to compensate for growth. One of the negative sequela is infrapositioning, due to the local arrest of the surrounding alveolar bone growth related to the continuous skeletal growth and development. Consequences include an unaesthetic dentogingival complex and complication in future prosthetic rehabilitation.

The presence of ankylosed teeth may complicate the eruption and development of the permanent dentition. Delayed exfoliation may cause deflected eruption paths for adjacent or opposing teeth. Hypoplasia, deflection, or impaction of succedaneous teeth may also happen. Localized or generalized loss of needed arch length, tipping of adjacent teeth over the the ankylosed tooth, or supraeruption of opposing teeth may occur. Increased susceptibility of caries and periodontal disease to the the neighbouring teeth, as well as the submerged tooth, may also be a consequence.

However, Kurol and Olson showed that infraocclusion and ankylosis aren't risk factors for future bone loss. Cephalometric and occlusal studies by Kula et al. displayed a high incidence of crossbites and dental aplasia. Most crossbites involved the buccal segments and/or anterior segments. It may be responsible for posterior open bite that subsequently leads to a tongue habit. Supraeruption of the antagonist until it reaches a contact point with the submerged tooth which is below the occlusal plane. All those may result in malocclusion.

VI. Diagnosis

The diagnosis of ankylosis is established after clinical and radiographic examination. Clinically, ankylosed teeth remain shorter or displaced relative to the adjacent teeth. Lack of tooth mobility, and dental

infraocclusion with a higher gingival margin may be observed. Upon percussion, it sounds solid while normal teeth have a dull, cushioned sound. These teeth have the classical, high-pitched, 'cracked-teacup' sound of ankylosis when percussed with a metal instrument. Recently, digital sound wave analysis has confirmed that an ankylosed incisor has a significantly higher proportion of the sound energy produced by percussion lies in the higher frequency bands, corroborating the characteristic sound. The simplest diagnostic test, subjective assessment of the sound from percussing the tooth with a metal dental mirror handle, is both highly specific and sensitive for the diagnosis of ankylosis.

Radiographically, there's obliteration of the periodontal ligament and blending of the rooth with the bone. Diagnosis of ankylosis on dental radiographs is often difficult; because the areas of ankylosis are small, easily located elsewhere on root surface than the minimal area that can be visible on the 2-dimensional image. This is due to the fact that the zone may be only a microscopic repair of cemental resorption by osteoid-like tissue continuous with the alveolar bone.14 The development of 3-dimensional imaging systems, such as computer-assisted tomography, offers an expectation of the ability to see small areas of cementum and root fusion, but this technology is not in wide-scale use. In addition to that, histologic studies in animals state that at least 20% of the root surface must be attached to bone before a lack of mobility and the percussion sound can be detected. Ankylosis usually starts in the labial and lingual root surfaces, which makes it difficult to detect radiographically in the early stages. There is often an angular defect of alveolar bone which is angled towards the ankylosed tooth.

However, the most important evidence of an ankylosed tooth is the inability to move with normal vertical dental alveolar growth or when it is subjected to orthodontic forces. As a result, it appears submerging into the alveolar process. However, there may be false impression of submersion of an ankylosed tooth due to continuous eruption of adjacent teeth.

It is hard to predict if ankylosis will occur after a dental accident, and it may be detected for several years in some cases. In a growing child, ankylosis can affect occlusal development. As a result, early diagnosis and an effective treatment plan are major steps in preventing eruption irregularities and severe malocclusion. Early detection of ankylosis does not alter the outcome which is tooth loss from replacement resorption. Yet, the clinician will have earlier warning of growth-associated infraocclusion. If the patient is not fully matured yet, early diagnosis will aid in deciding the appropriate timing of interventions to decrease morbidity and increase better long-term results.[36]

VII. Treatment

The treatment of an ankylosed tooth is not possible by conventional orthodontics. However, the treatment options include extraction with several procedures following it depending on the case. The first is reimplantation in an ideal position with osteotomy of the dentoalveolar segment, if needed. The second is orthodontic space closure with a substitute. If a patient has completed growth, placement of an osseointegrated implant or a prosthetic replacement are two more options. Distraction osteogenesis is a contemporary treatment which attempts to bring an ankylosed tooth to the occlusal plane. Growth of the patient in this case is of special concern because of the risk of vertical relapse. Other techniques include surgical luxation, corticotomy, or ostectomy.

Luxation is the mechanical breakage of the ankylosis without compromising the nutrient vessels at the apex. It can be done by firmly grasping the tooth with the appropriate forceps and gently rocking it in a buccolingual and mesiodistal direction. After the reparative process, the the periodontal ligament continuity is restored to allow eruption. Geiger and Bronsky (1994) advocated using apply orthodontic force after the luxation, since it provides a functional tooth in the presence of alveolar bone.

Corticotomy is a surgical technique in which a small segment osteotomy is used to reposition both the ankylosed tooth and the adjacent alveolar bone. Localized ostectomy of the fused bone is a procedure where the affected osseous tissue is excised, which works only if the ankylosis is in the crestal area because elsewhere it is not readily accessible to surgery.

Ankylosed teeth, which could provide anchorage during an orthodontic treatment, should not be extracted. However, these teeth should not be the cause of malocclusion and should not jeopardize the treatment course.

The most accepted treatment option of ankylosed teeth is their surgical removal which may be accompanied by traumatic alveolar bone tear, particularly in the presence of a thin maxillary buccal plate. Yet it may lead to esthetic bony ridge deformities and might interfere with the following prosthetic treatment.

In 1984, Malmgren et al. suggested an alternative treatment to the extraction of ankylosed teeth which attempts to preserve its surrounding alveolar bone and prevent infra-positioning. It is called decoronation. It involves gingival mucoperiosteal flap elevation, subcrestal removal of the tooth crown leaving the root in its alveolus to be replaced by bone. Histological and radiographical findings showed few inflammatory changes around vital and endodontically treated roots that had been submerged for the purpose of alveolar bone preservation.

After complete crown removal, the existing root canal filling, if present, is removed to prevent foreign body reaction. The canal is thoroughly rinsed with saline and intentionally filled with blood to promote additional replacement resorption from its internal aspect, keeping the external replacement resorption without interruption. The mucoperiostal flap is sutured over the decoronated root leaving until it is gradually fully resorbed.

Whether the ankylosed tooth is deciduous or permanent, the time of onset, the time of diagnosis, and the location of the affected tooth are the factors that determine the course of treatment.

If the ankylosed tooth is deciduous and has a successor, ideal treatment is extraction immediately and placement of space maintainer, if necessary.

If the tooth is deciduous and without a successor, two options develop depending on the onset. If the onset is early with a chance of submergence, treatment includes extraction and space maintenance. If the onset is late, proximal and occlusal contacts may be built up at maturity.

If the ankylosed tooth is permanent and the onset is early, the tooth should be luxated. If it doesn't work, it must be extracted. It should not be permitted to "submerge."

If the onset of ankylosis is late, the permanent tooth should be luxated. If the attempt is unsuccessful and the tooth does not "submerge," it may be built up at maturity.

A deeply "submerged" ankylosed tooth, deciduous or permanent, must not be disrupted unless it is infected or causes threat to the occlusion.

Another treatment module is the transplantation of a developing tooth, usually lower second premolar, to replace the missing maxillary incisor. The timing of the incisor extraction and its transplantation should be carefully planned. When the incisor is extracted before the date of transplantation, it should be performed as soon as possible except when space is needed. Then, space generation must occur before transplantation.

After that, the donor tooth is reshaped to reproduce morphological features of the natural tooth. The donor tooth should be tried into the previously prepared recipient site with checking the fit of the gingival tissues around it since fifty percent of transplantation success depends on it. The transplant should be placed slightly below the occlusal plane with suture, which must be removed in a week. Next, the flexible stabilization and composite adhesives wire can be installed to connect the transplanted incisor with the adjacent teeth. A physiological splint can be used to allow certain movements of the tooth to immobilize it enough to facilitate pulpal and periodonatal healing and minimize the potential adverse effects. Prescription of prophylactic antibiotics before the procedure and for a week following the surgery is a must.

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