

***TRABAJO DE FIN DE GRADO***

***Grado en Odontología***

**TREATMENT STRATEGIES FOR ANKYLOSED  
TEMPORARY MOLARS**

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## **ABSTRACT:**

Dentoalveolar ankylosis is defined as an eruption defect induced by the fusion of the alveolar bone with the cement or the dentin of the tooth related to the periodontal ligament loss. Its etiology is still discussed but it is known to have a genetic association and a relation with a disruption of the periodontal ligament metabolism. This pathology often leads to alterations in the dentition such as infraocclusion and disruptions of the path of eruption leading to arch length loss.

Although ankylosis is predominantly found in primary dentition, it is a frequent disease and its incidence is higher in females than males, affecting also significantly more mandibular molars than maxillary molars. The most frequently ankylosed tooth is the lower first primary molar.

Nowadays, diagnosis techniques include intraoral exploration with movement checking, radiological study for exfoliation or periodontal ligament disappearance. When it comes to treatment, we distinguish two situations: when there is a premolar precursor and when there's an agenesis of the premolar but it can remain difficult for the clinician to come up with the best therapeutic choice.

## **OBJECTIVES :**

This study is a literature review that aims to analyze the different therapeutic options for ankylosed temporary molars.

This study will be divided in two main sections: the first one will focus on ankylosis of the first temporary molar with presence of a premolar precursor and the second one will deal with the agenesis of the bicuspid and the different therapeutic approaches that come with it.

### **MATERIALS AND METHODS:**

Searches were focused on PubMed and only included scientific publications from the last 15 years, in english and where the text was available entirely. To do so, key words were used such as dentoalveolar ankylosis, infraocclusion, periodontal ligament.

Publications were then added to the Mendeley reference management base and it allowed for the suggestion of other articles.

## **RESUMEN:**

La anquilosis dentoalveolar se define como un defecto en el proceso de erupción provocado por la fusión del hueso alveolar con el cemento o la dentina del diente relacionado con la pérdida del ligamento periodontal. Su etiología aún se discute pero se sabe que tiene una asociación genética y una relación con una alteración del metabolismo del ligamento periodontal.

Esta patología suele provocar alteraciones en la dentición como la infraoclusión y la alteración de la trayectoria de erupción, lo que lleva a la pérdida de la longitud de arcada.

Aunque la anquilosis se encuentra predominantemente en la dentición temporal, es una enfermedad frecuente y su incidencia es mayor en las mujeres que en los hombres, afectando también significativamente más a los molares mandibulares que a los maxilares. El diente más frecuentemente anquilosado es el primer molar temporal mandibular.

En la actualidad, las técnicas de diagnóstico incluyen la exploración intraoral, el estudio radiológico de exfoliación o la desaparición del ligamento periodontal. En cuanto al tratamiento, distinguimos dos situaciones: cuando hay un precursor permanente y cuando hay una agenesia del precursor, tratando de facilitar al clínico la selección de la mejor opción terapéutica.

## **OBJETIVOS :**

Este estudio es una revisión bibliográfica que pretende analizar las diferentes opciones terapéuticas para los primeros molares temporales inferiores anquilosados, dividido en dos apartados principales: el primero se centrará en la anquilosis de

del primer molar temporal con presencia de un precursor premolar, y el segundo tratará la agenesia del premolar y los diferentes enfoques terapéuticos.

### **MATERIALES Y MÉTODOS :**

Las búsquedas se centraron en PubMed y sólo se incluyeron publicaciones científicas de los últimos 15 años. Para ello se utilizaron palabras clave como anquilosis dentoalveolar, infraoclusión y ligamento periodonta entre otrasl. A continuación, las publicaciones se añadieron a la base de gestión de referencias de Mendeley.

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## **1. INTRODUCTION :**

### **1.1 Terms confusion :**

Nowadays, several terms are used to talk about ankylosis making it difficult to find a consensus on an exact definition of the term (1, 2). Indeed, in the literature, we can find terms such as submersion, retention, intrusion, hypotrusion, etc. All of these related to a same theme but describing mostly its consequences (2). These different nominations used tend to create a general confusion around ankylosis explaining the different diagnostic criterias given by the different references.

### **1.2 Definition :**

« Ankylosis » comes from ancient greek and means « stiffness of a joint ». Dentoalveolar ankylosis is defined as an eruption defect induced by the fusion of the alveolar bone with the cement or the dentin of the tooth with obliteration of the periodontal ligament. (1) There isn't any separation by the periodontal ligament and the periodontal ligament space doesn't exist anymore creating a direct contact between the tooth and the surrounding bone. When the cementum starts its resorption, it's replaced by bone tissue which creates a continuity between both substances and can be reversible and is either partial or total. It can happen at different moments of one's life starting during the eruption process, or after the tooth as emerged in the oral cavity and it is or still isn't in occlusion with its antagonist. The consequence of these perturbations is a cessation of the displacement of the tooth, whether it is natural (physiological eruption) or provoked with the help of orthodontic

treatment. Therefore, the eruption process stops and the tooth remains static at the site (horizontal parameter) and occlusal level (vertical parameter) where it suffered the disruption. The adjacent teeth, if undisturbed, follow their physiological course of eruption, accentuating the discrepancy between the overall occlusal plane and the occlusal plane of the ankylosed tooth that appears more and more submerged. As eruption follows its course, bone growth follows as a concomitant process.

### **1.3 Etiological factors :**

The risk factors associated to it are classified into genetic or intrinsic factors and local or extrinsic factors but its etiology is still discussed and gives rise every year to new studies throughout the world. Nevertheless, it is known to have a genetic association and to be related with a disruption of the periodontal ligament metabolism (3, 4, 5, 6).

Local extrinsic etiological factors of ankylosis include mostly mechanical hypotheses. Among these, we find the perturbation of local metabolism provoking the degeneration of the periodontal ligament as well as any local or occlusal traumatic process such as luxation, abnormal vertical or horizontal pressure over the tooth during mastication. Hypotheses also relate an abnormal pressure of the tongue against the tooth, traumatism from accidental situation or of iatrogenic origin during dental treatment and periapical infectious or inflammation process. Authors also mentioned the influence of bone alterations in the pathological process of ankylosis and a local deficit in vertical bone growth as well as an imbalance in the apposition and resorption



processes which were all found to be risk factors for the appearance of the pathology. It is moreover important to mention that the reimplantation of an avulsed tooth can lead to its ankylosis. However, even though literature gives several possible risk factors for ankylosis, many authors state that they aren't systematically present and have, therefore, a relative importance (3, 4, 5, 6).

The second class of etiological factors for tooth ankylosis are the intrinsic or genetic factors and these ones were proven to be of more importance. Early studies demonstrated an increased prevalence among some families and children who presented the condition were very much likely to have a sibling presenting the same condition. (4) Not only was the presence of the condition found with a family pattern but also the degree of affectation as well as the teeth affected. Other dental pathologies are sometimes associated with ankylosis and some authors decided to study this association (1), highlighting the increased prevalence of supernumerary teeth, agenesis of the permanent teeth, eruption defects (ectopic canines, premolars or first molars), microdontia, and composition defects such as enamel hypoplasia (1,4).

#### **1.4 Diagnosis :**

Dental ankylosis' most common diagnostic indicator is the infra-occlusion. Infraocclusion is a clinical term used to describe a tooth that is positioned under the occlusion plane and has therefore lost contact with the antagonist. Pathological situation can vary from a mild infraocclusion to a severe infraocclusion with complete inclusion of the tooth concerned inside the bone. (1, 3)

Nowadays, diagnosis is based on intraoral exploration and radiological study (1). Intraoral exploration includes mobility checking and percussion. A physiologically erupting tooth is associated to both an ability to move when submitted to forces and to a specific sound. When ankylosed, a tooth is unable to move whether it is submitted to forces through the dental mirror of the physician or through orthodontic appliances (7). Absence of mobility is therefore a very popular diagnostic tool among clinicians. Percussion in ankylosed teeth creates a clear and solid sound (1,7) whereas healthy teeth sound would be diminished by the presence of the periodontal ligament, playing the role of a shock and sound absorber. Visual diagnosis of infraocclusion isn't relevant as it is very subjective to the observer and has a low sensitivity, discarding many false negatives due to mild infraocclusion (1, 7).

Radiological techniques are the most common tool to detect ankylosis. They allow the clinician to follow the exfoliation course of the tooth studied, to monitor the periodontal ligament disappearance and to detect the presence of infraocclusion. Possibilities are endless when it comes to radiological diagnosis and clinicians can use orthopantomography, periapical or occlusal Xrays as well as three dimensional imaging and Computed Tomography (CT Scans) (1). The use of CT Scans isn't universal and some authors, such as Bertl, state that they are not commonly used as first diagnostic tool as they expose the patient to high levels of radiations (7) while some others like Kirzioglu prone their use in a more systematic way. CT Scans allow for further exploration in specific cases of surgery to allow the exact localization of the alveolar nerve and therefore prevent its injury during teeth extractions (1,8). It can also assess the risk of fractures during surgical removal of teeth. Rege et Al support this theory with the study of 206 teeth suspected from ankylosis by the means of grey pixels

intensity measurement with Cone Beam Computed Tomography (CBCT) (9).

Radiological observations allowed the clinicians to complement studies based on intraoral exploration done with percussion and observation. They allowed to diagnose even mild infraocclusions of a few millimeters increasing therefore the prevalence in population studied (9).

It is however important to note that on radiography it was found possible to observe disappearance of the periodontal ligament only when affecting the proximal surfaces of the roots and not when it affected the vestibular or lingual/palatal surface (7).

Bertl (7) also developed the possible use of resonance frequency analysis (RFA) used in diagnosis in implantology as a diagnostic tool of ankylosed teeth. This method is normally used to evaluate the rigidity of the connexion between the implant and the bone which can be considered as the ankylosis of the implant inside the alveolar bone. Therefore, Bertl decided to evaluate the possible use of RFA in ankylosis diagnosis, transposing the use of this tool to actual tooth tissue. After the study of the population, he found a specificity of 100% and a sensitivity of up to 53% and concluded that RFA could be used as a complement to intraoral exploration and radiography (7).



**Figure 1** : Resonance frequency analysis dispositive tool to assess tooth ankylosis (7)

In the different studies examined, when it comes to infraocclusion, a clinical protocol was observed. The study populations were divided into subgroups depending on the distance between the occlusal surface of the tooth and the overall occlusal plan and it allowed to make different prognosis. For example, in the study of Silvestrini Biavati A. et Al. (10), the group of patients who presented ankylosis was divided into subgroups as followed: first subgroups from 1 to 2mm, second subgroup from 2.5 to 4mm and 3rd subgroup from 4.5 to 9mm. On another hand, Brearley classified the levels of infraocclusion from « slight » (1mm discrepancy) to « severe » (occlusal level below gingival interproximal tissue) with « moderate » (occlusal surface at the level of the interproximal contact point) in between (1).

Francisca Dias Schiappacasse (11), in 2019, conducted a cross-sectionnal study where she assessed the prevalence of infraocclusion in primary molars of children of 7 and 8 years old. She divided them into subgroups depending on the severity of the infraocclusion and obtained different percentages. Indeed, she observed that among the 349 children examined, a total of 41,78% of them presented the condition. About

the severity grading, 82% of the patients presented with mild infraocclusion, 15,28% presented with moderate infraocclusion and just 2,66% of them suffered from severe infraocclusion. She concluded that the prevalence was high in the population studied but that the great majority of the cases presented with mild infraocclusion compared to the proportions of moderate and severe cases. The variation in the percentages obtained from the different studies can be explained by the differences in the populations included, being the condition mostly present in children of 7-8 years old. (11)

Signs of ankylosed teeth depend on whether it appears on permanent or primary dentition, as well as on some other factors such as the sex, the tooth affected, the age, etc. In the literature most commonly found general signs include a decreased number of teeth, an abnormal composition of the dental tissues (atypical enamel, dentin or cementum), an enlarged mandibula and of course: an infraocclusion (11).

Signs are found mostly in anterior teeth as ankylosis can lead to aesthetic problems due to uneven incisal line, asymmetry in the smile line and space between teeth (diastemas). In opposition, an ankylosed posterior tooth might not be diagnosed as early as an anterior tooth as it can be asymptomatic and won't be noticed due to the slow evolution of height difference between teeth (11).

### **1.5 Epidemiology :**

Concerning prevalence and epidemiological datas, it is hard to give a percentage that would satisfy every author as we can find many of them, ranging from 0.07%

(Dechaume and Cauhepe, 1948) to sometimes 40% (3). These important variations among studies can be explained by the different criterias used by the clinicians to detect ankylosis of temporal teeth. Some of them weren't taking into account its different severity grades and others were only recording the most severe cases. It is important to note that some selection bias was present in some studies where the screening was done on young populations or among families that presented the condition, increasing therefore the occurrence of the disease. Mueller et Al. in 1983 conducted a study aimed to investigate the ethnic distribution of ankylosis, wondering if the condition was more prevalent in some ethnical populations. The population screening was done in 1895 children from 7 to 12 years old who were examined radiographically. Results showed a total incidence of 9.9% and the ethnical distribution showed a significant higher percentage in children from Hispanic (11.5%) and Caucasian (10.6%) origin compared to the other ethnic groups (African Americans for example). They also found out that deciduous first molar was twice more affected compared to temporary second molar (27). A longitudinal retrospective study was produced at the Orthodontics and Paediatric Dentistry Department of the Genoa University School of Dentistry in 2011 where 512 subjects were examined following a protocol divided into intraoral examination and radiographic exploration. This study is among the ones that focussed on the deciduous teeth ankylosis and only included children of age comprised between 5 and 15 years old. Silvestrini Biavati A. et Al., in this study (10), detected the ankylosis of one or more temporal teeth in 6.6% of the population studied. To sum up, studies showed that ankylosis was more prevalent in mandibular teeth than maxillary ones and first molar was more affected than second molar. (1)

### **1.6 Clinical risks:**

Ankylosis of deciduous teeth, other than causing aesthetic problems in the children who suffer it, can disrupt physiologic mechanisms and have important consequences. It was found that infraocclusion could lead to impaired bone support, periodontal problems, delay or impairment in the eruption of the permanent tooth (1, 4). In other cases (3,4,8), it was found a tipping of the adjacent tooth towards the infraocclusion side because the contact point was either absent, either too low (1). Extrusion (over eruption) of the antagonist tooth to reach occlusion with the infraoccluded tooth was also present in different studies. Functional impairments were also found as a result of the disrupted occlusal plan: inability to chew correctly or to perform good oral hygiene techniques elevating the risk for carious lesions and periodontal affectation (1,13).

Another parameter was examined by Dias et Al: the vertical alveolar growth in patients with ankylosed primary molars. After superimposition of images and digital subtraction radiography, they concluded that ankylosis was associated with a reduction in the vertical alveolar development in surfaces adjacent to this ankylosis site (14).

The most important focus of the clinician in case of first primary molar ankylosis is the disruption of the path of eruption of the underlying premolar that would cause the loss of the arch length (14).

When it comes to treating the ankylosis of the first primary molar, we distinguish two different situations depending on the presence or absence of a premolar precursor as these two situations call for different treatments. Review of the actual

literature showed that despite the consequent amount of studies, finding the adequate treatment remains a challenge and the clinician sometimes fails to come up with the best therapeutic choice (1).

## **2. OBJECTIVES :**

This paper is a literature review aimed to analyse the different therapeutic options when being presented a patient with lower first primary molar ankylosis, including the most common treatments as well as some other options less common but clinically relevant found throughout scientific studies.

## **3. MATERIALS AND METHODS :**

Searches were conducted on different databases such as PubMed and Mendeley using keywords. Amongst them were used: dentoalveolar ankylosis, infraocclusion, retained teeth, contained teeth, hypotrusion, intrusion, submersion. Articles were then added to the Mendeley reference management database which then suggested other publications depending on the first selection. Only relevant scientific publications were added, most of them being published in the last 15 years. A minimal number of the included bibliography was published before this date but were found nevertheless relevant and were therefore added.



## **4. DISCUSSION**

### **4.1 Presence of a premolar successor:**

There isn't any clear conduct line to follow when it comes to treatment of dental ankylosis in deciduous teeth and it will always depend on several factors. Among these factors, we find the severity of the infraocclusion and its evolution in time, the associated possible future complications depending on the situation, the position of the underlying tooth germ and the developmental state of the ankylosed tooth (1). Indeed, the ankylosis has to be diagnosed and treated (or not) quicker if the infraocclusion is more severe as the consequences will be of higher importance (15). It can also be seen the other way around, focusing on the onset of the disease. Indeed, associated complications aren't the same whether the pathology happened early in the development of the dentition or later when the tooth is already partially erupted. Late onset ankylosis are presenting with slight infra-occlusion as the development has already followed part of its course whereas early onset ankylosis, if untreated, presents with more symptoms. (1)

Moreover, about associated complications and possible future pathologies, some situations call for a treatment instead of another: already installed malocclusions as well as mesioversion of the first permanent molars can lead to a severe space loss. The position of the subjacent tooth germ is also to be taken into account as ectopic eruption can call for early surgical removal (15).

Dr Lariato conducted a case study on the follow up of a patient who presented with ankylosis of the first primary molar 84 and was aged 9 years old (15). Having been presented this patient late in the course of the pathological condition, she was able to perform orthodontic repositioning but with several appliances and in a very fastidious and long way. Therefore, she stated that efficacy of the treatment might have been present after late diagnosis of ankylosis but that the treatment wasn't efficiently performed due to its complexity. The efficiency of a treatment is defined as the performance of the treatment in a minimum amount of time. Lariato explains that an early extraction of the ankylosed tooth would have prevented such a complicated and long treatment and allowed the patient to develop a normal arch length and physiological occlusion. Therefore, diagnosis of the condition by the dentist is very important as well as a rapid referral to an orthodontist whenever space has begun to be lost as it can impact the treatment efficiency (15).

The first section of this review will be focusing on the different treatment possible when dealing with a patient who presents an ankylosis of the first primary molar but with the presence of the premolar successor. This situation is the one that gives rise to more interrogations for the clinician as he will want to prevent harm on the underlying bicuspid as well as the disruption of its path of eruption. In this first part, we will then try to answer the question: « should we extract or not? » (15).

#### **4.1.1 Monitoring:**

When the permanent successor is placed physiologically in the bone, the ankylosed

temporal molar is likely to follow its natural course of exfoliation (3) but most of the times with a delay of 6 months (1,4) compared to non-included deciduous teeth. In this case, Kuroi says that it's unnecessary to extract the impacted tooth as the situation will get back to normal after shedding of the tooth. In this situation, he advises not to do anything and monitor the correct exfoliation of the temporal tooth taking into account its probable delay. Indeed, in that case, conservation is advised as extracting the tooth would lead to an inevitable bone loss that can be irreversible. Therefore, whenever the situation allows it, it is advisable to maintain the tooth in the arch to prevent for bone tissue loss associated with exodontias. This therapeutic choice can be made when there are no major occlusal disruptions (mild infra occlusion), the progression rate of the infra occlusion is slow, the risk of facing space loss hindering the eruption of the premolar is low and the germ of the permanent tooth is correctly placed (non ectopic eruption) (1, 3, 4).

#### **4.1.2. Restoration of occlusal height:**

In the case of choosing to maintain the infraoccluded tooth in the arch, monitoring is key and regular check-ups are mandatory to follow the course of the pathology and the correct eruption and exfoliation of the teeth (1,4). But monitoring isn't the only option and some clinicians advise for restoration of the occlusal height of the ankylosed tooth to restore the occlusion. This is explained because maintaining infraoccluded teeth in the arch can cause perturbations in the surrounding teeth such as rotations or versions (3).

Indeed, Jenkins and Nichol performed a study of 3 cases of primary molar ankylosis with presence of premolar successor. In their first case, the 7 years old child presented with infraoccluded primary molar with no associated complications and physiological growth of the underlying premolar. They chose a conservative treatment, leaving eruption follow its course without restoring the tooth but with close monitoring once a year. The patient was shown to develop tilting of the adjacent tooth towards the infraocclusion site and space loss was then observed. (3) The second patient they studied was a 13 years old who also presented ankylosis of her primary molars. Given her age, monitoring wasn't an option and they instead could only notice the damages as the tooth had been left in without restoration or monitoring. Here again, the patient presented with severe tilting of the permanent adjacent premolar towards the infraocclusion site and the treatment was surgical extraction of the ankylosed tooth. The third patient they studied allowed for the same observations and here again, surgical extraction was needed (3).

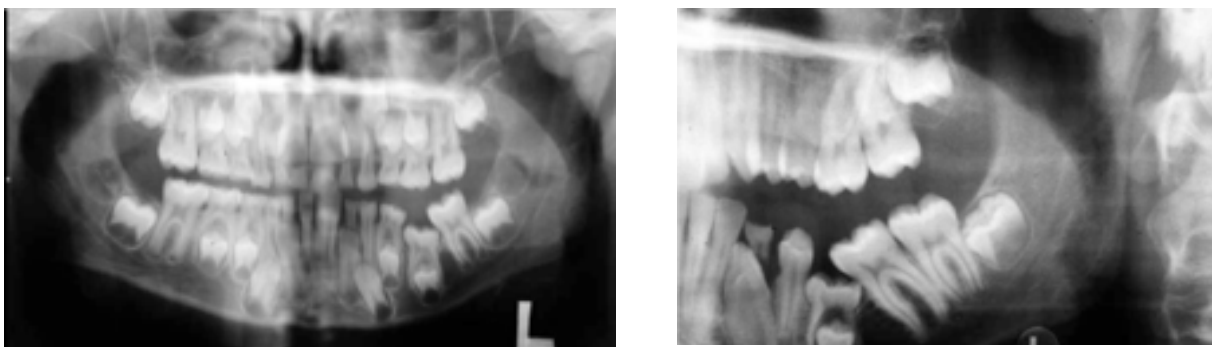


Figure 2: orthopantomographies of the first patient at two different ages: first at age 7 and second at age 12. (3)

Therefore, some authors advise for the restoration of the infraoccluded temporal tooth to prevent further complications by establishing occlusion as well as proximal contacts. This theory was supported by several authors (16,17,18) and it was also found that in some cases, the re-establishment of contact points and occlusion allowed the tooth to restart its exfoliation process (19).

In addition, Loriato states that restoration of dental height isn't effective if the ankylosed tooth is submucosal as the complications are already present and established and surgical exposure to perform the restoration isn't recommended (15).

Silva de Moura (20) performed a study of 2 cases of ankylosis of primary molars with permanent successors in children aged 3 years old and 5 years old. Here, the goal was to monitor the possible restorative therapy for such condition by means of composite resin placement, one in crown, the second one as a direct placement. In the first case, the author explains that even if early treatment is advised, it is important to note that the placement of composite resin in a child aged 3 years old can be complicated. In this first case, the patient wasn't cooperating enough to allow for easy placement of the composite resin crown. In the second case, the child didn't allow for impressions taking with alginate nor for restorative direct procedures and therefore the clinician had to wait until the patient turned 5 and showed more cooperation. In this case, the author states that even if an extra session is necessary for the laboratory preparation of the crown and the casts making, placing a crown instead of performing a direct composite restoration allowed for a time gain compared to the incremental technique of composite placement. (20). This study also adds the preference of placing ceramic crowns instead of preformed metal crowns due to its apparent lack of

scientific evidence and its obvious lack of aesthetics (20).

To sum up, to restore the physiologic height of the tooth, there are different options but most common are the use of a restoration of composite resin or the placement of metallic preformed crown (3, 15, 16, 17, 18, 19, 20).

#### **4.1.3 Surgical extraction:**

These therapeutic options are chosen to allow the correct reabsorption of the ankylosed teeth within the 6 months following the normal date. After these 6 months have passed, if no exfoliation is noted, it is advised to extract the ankylosed tooth (1,4).

When being presented a case of a patient suffering first temporal molar ankylosis along with disruption of the path of eruption of the premolar successor, literature shows that clinicians advise for its surgical removal. The next step is to determine the need or not for space management with the help of orthodontic space maintainers (1,4). Study of the literature shows that most clinicians were choosing this therapeutic options to prevent harm on the permanent premolar depending on the situation. It will therefore be advised when the patient presents a severe or rapidly progressing infraocclusion, important occlusal disruption due to rotations, high space loss risk, ectopic eruption of the underlying premolar, risk of periodontal impairment, presence of associated pathologies such as caries or bad hygiene techniques. The performance of an early or late extraction will depend here again on the situation and on the moment the condition was detected (3, 18, 21, 22).

Extraction will be considered early whenever it is performed before the usual age of physiological loss after exfoliation. Early extraction will only be recommended in case of severely infraoccluded ankylosed tooth and when space loss is inevitable due to occlusal perturbations (3). It is however important to note that performing exodoncia at this stage could result in complications such as tooth fracture and even disruption of the underlying tooth bud development (4). An extraction will be considered « late » when performed after the usual time of natural loss. In the case of an ankylosed tooth, 6 months are considered a natural delay. When this time has passed, some authors such as S. L. Ekim recommend extraction of the tooth (23). Other authors, on the other hand, maintain their position about the criterias for extraction: only if we observe a severe disruption of the arch will we consider this treatment option (4).

Loriato states that, when performed on time, surgical extraction of the ankylosed primary molar results in the pursuit of the development of the premolar successor with normal development of the root to its desired length (15). She also documented the fact that however, in some cases, when performed too late, it can result in alterations in the premolar successor with crown morphology damages which will impair the occlusion and call for restorative management such as composite or crown placement (15).

After the extraction is performed, the treatment goal is to manage the space to prevent loss of arch length and allow further eruption of the subyacent premolar. To prevent the adjacent tooth to mesialize and to tip towards the extraction site and therefore provoke a loss of space, we need to place a space maintainer until the

growing premolar is able to play its role in the arch (1, 4).

#### **4.2. Absence of premolar successor :**

In this part, we will focus on another situation where the pathological process here isn't only the ankylosis of the first primary molar but also the absence or agenesis of the premolar successor.

In 1994, Winter GB studied the prevalence of bicuspid agenesis in relation with ankylosis of the first primary molar and concluded that about 17% of primary molars ankylosis were associated with such agenesis (24).

In this case, we don't have the option to wait for the normal course of exfoliation of the temporal impacted tooth to happen as the forces produced by the eruption of the successor aren't present. Spontaneous exfoliation of the tooth is, therefore, very unlikely (1). However, it was noted that in some rare cases, the resorption of the temporal root could follow its course and still give rise to an impaired position in the arch (infraocclusion). In this situation, the challenge is to determine if the ankylosed tooth, if left in place, will later suffer overly decreased occlusion or periodontal pathologies along with impaired bone support. In the literature, the major options were either to maintain the tooth and leave it in place depending on the severity of the infraocclusion; or to extract it. In case surgical extraction was chosen, the following management of the absence showed various



options. Indeed, among most common treatments was found space closure along with transplantation and prosthetic replacement (1).

Here again, the choice for one or another treatment must be guided by the severity of the infraocclusion, the possible future associated complications, the root development of the tooth, the alveolar bone support, the state of the tooth (presence or absence of restorations or carious lesions) along with other parameters (1).

#### **4.2.1. Maintaining:**

When presented with a case of a patient with physiological conditions apart from the ankylosis and the infraocclusion isn't too severe, not impairing occlusal movements, it is mostly chosen to maintain it in the arch as long as possible. This technique is also motivated, as when there is a premolar precursor, by the fact that bone loss follows extractions. It can therefore be left in place without restoration or it can be restored like developed earlier in this review to prevent for complications in the permanent dentition such as teeth versions, tilting... To do so, treatment aims to re-establish interproximal contacts or maintain mesio-distal dimensions as well as restoring the occlusion. Literature shows that this technique is developed using composite resin placement as a direct build-up, incrustations such as composite inlays or onlays, use of preformed metal crowns or porcelain crowns (3,25).

To support this theory, Lygidakis (25) develops a technique to maintain infraoccluded primary molars that need to be kept in the mouth. He documented the

case of a 14 years old patient suffering this condition. His treatment consisted in reshaping the tooth starting with a reduction of its mesio-distal diameter with a bur and followed by the placement of a composite restoration. This composite restoration was placed by filling up a preformed metal crown with composite and then removing of the crown to end up with a normally shaped tooth. He starts with the building up of a composite core that allows for easier placement of the crown. He concludes that this technique is an easy way to perform a restorative treatment on an ankylosed tooth that we need to save for further prosthetic placement, and that it only requires simple and every day material. Another of the advantages he finds to his technique is that this treatment only requires one session and doesn't require any laboratory session as it can be done by the clinician himself. (25)



Figure 3 : placement of a composite resin restoration by means of a preformed metal crown (25)

Maintaining the place of the tooth in the arch is also motivated for future purposes, when the tooth is lost and there is the need for a prosthetic placement. By keeping it, we maintain the space and bone tissue level for further placement of an implant or other prosthesis. This technique therefore allows to use the ankylosed tooth as a natural space maintainer when space closing isn't the favorable option (4).

#### **4.2.2 Luxation:**

It was also found in the literature the option of realizing a « luxation » of the ankylosed tooth. This treatment consists in luxating the tooth with different extraction forceps in a mesiodistal direction to break the connexion between the ankylosed tooth and its surrounding alveolar bone to allow it to follow afterwards its natural course of eruption. This technique is still quite discussed and even if it is become a more common option for permanent teeth, the risk in primary molars is that the roots are weaker and therefore more prone to be broken during luxation. Therefore this technique isn't of choice for primary teeth because of its doubtful outcome and calls for further investigations. (18)

After it was stated that temporal ankylosed teeth could be left in place and not extracted, various dentists investigated the time such teeth could actually stay in the mouth. Some studies showed that temporal teeth, if well managed and periodically checked can be kept in place inside the mouth for up to 20 years allowing for the patient to undergo prosthetic procedures he wasn't permitted earlier for development reasons such as implants. (1,4). In another 10 years prospective study, it was also

observed that temporal molars left in place were very likely to survive in cases with congenital premolar agenesis (26). Indeed, Sletten followed 28 patients over a period of 12 years and concluded that submergence changes were negligible as well as the roots shortening; therefore healthy temporal mandibular molars could be retained for many years. This author added that in case of loss of these retained teeth, they still had a lifetime that superated some prosthetic rehabilitations (bridges, implants, etc) (26).

#### **4.2.3. Surgical extraction:**

When the patient is suffering from ankylosis with aplasia of the premolar associated with other complications, literature shows that it is mostly recommended to extract it. These complications can be seen in patients with severely infraoccluded teeth, important root resorptions, fractures, infectious process (abscess), etc ; and are usually associated with a bad prognosis. In this cases, surgical removal is advised (1,14,27) and the earlier the extraction, even if ankylosis was discovered late, the better the prognosis. Indeed, it is important to keep in mind that late exodontias of ankylosed teeth result in associated risks for the alveolar bone (14).

SK Mishra Et. Al. conducted three case studies where they documented the treatments of 3 different submerged and impacted primary molars in three children aged from 7 to 9 years old. They concluded that in the case of severe tilting of the permanent adjacent tooth, surgical removal was advised followed by placement of prefabricated band and loop space maintainer (22).

#### **4.2.4. Orthodontic bone stretching:**

As it was previously stated, ankylosed teeth resist orthodontic traction because of their anchorage. However, Bousquet states that « orthodontic bone stretching » can be an option to get around this problem and relocate the tooth to its correct position (27). This technique associates surgery to orthodontics by means of flaps and osteotomies followed by heavy orthodontic traction. The clinician concludes that this technique allows easier replacement of the tooth but that the results might not be stable over time as the jaw keeps growing and discrepancies may reappear. This technique therefore calls for further clinical trials (27).

#### **4.2.5. Prosthetic rehabilitation after surgical extraction:**

If the choice of the clinician was to maintain the ankylosed tooth, even after good maintenance and periodic follow-up of the eruption, the tooth will eventually exfoliate or be lost for various causes such as trauma, periodontal disease, caries, etc. If not, if the tooth was left in place for prosthetic reasons, it comes a time when the placement is possible and the clinician needs to make a choice depending on the situation. When the ankylosed tooth is extracted, if no space maintenance was performed, the prosthetic space might be lost and therefore the choice of which prosthesis is the most adequate will depend on it. The options for rehabilitation here include implant placement (25,27) or fixed prosthesis such as bridges (28). Periodontal surgery such as gingival graft can be needed to restore the amount of gingiva on the

alveolar ridge if choosing to place a bridge to restore the ankylosed primary tooth. (27). Regarding implant restoration, a graft can also be needed to allow regeneration so that the level of bone might be increased and restored. (27)

Sidhu performed a case study of an 11 years old patient presenting with ankylosis and severe infraocclusion of the first primary molar (28) as well as agenesis of the premolar successor. He investigated the possible restorative treatment by means of a fiber reinforced ceromeric bridge and orthodontic treatment. The first step of the treatment was surgical extraction of the ankylosed teeth and following orthodontic therapy by means of removable appliances, the fixed ones being refused by the patient and her family. After orthodontic treatment was accomplished and well carried out, prosthetic space was assessed and the options were to place a fixed-fixed bridge such as a Cantiliver bridge or a Resin bonded bridge (28) or a ceromeric fiber-reinforced bridge. When compared to other restorative options, the ceromeric fiber-reinforced bridges showed a high survival at 5 years post-placement. Also, it proved a very positive esthetic outcome as the fibers are translucent and can easily match. It is however important to note that there are not much proves in the literature that document the use of such bridges for ankylosed primary molars and it therefore calls for further investigations (28).

#### **4.2.6. Orthodontic space closure:**

Sometimes, the only option for the clinician being presented with ankylosis of the first primary molar in a patient with absent successor premolar is surgical

extraction of the ankylosed tooth followed by orthodontic space closure. In case we want to achieve space closure, the best results are provided when the extraction is realized early to allow for a mesial drift of the permanent molar (28). This will indeed limit the loss of alveolar bone and will allow the orthodontic appliance placement to take place during the adequate age for orthodontic response (28).

### **CONCLUSION:**

The development of the occlusion of the young patients is to be monitored thoroughly whether the permanent dentition has started to appear or not. Indeed, it can allow for early diagnosis of conditions such as ankylosis that will further require an orthodontic treatment which will lack efficiency if the pathology isn't diagnosed on time and can develop morphological changes on the permanent successor. This pathology calls for multidisciplinary approach, having dimensions in the orthodontic, prosthodontic, restorative, periodontic and surgical field.

## **RESPONSABILITY**

In the past, when being presented a case of ankylosis of a primary tooth, the majority of clinicians used to choose to extract it, thinking that its prognosis would lead to this outcome. This project has for objective to question the extraction and instead to make the dentist question himself on the different other options available to prevent the tooth from being lost.



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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

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### 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 familial 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.

## Short communication

# Resonance frequency analysis: a new diagnostic tool for dental ankylosis

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Ankylosed teeth are considered in orthodontic treatment planning; however, diagnostic tools to quantify the rigidity of the tooth-to-bone connection are rare. Resonance frequency analysis (RFA) can quantify the rigidity of the dental implant-to-bone connection and thus may serve as a potential diagnostic tool to identify ankylosed teeth. To test this assumption, we examined 15 and 30 primary mandibular molars, with and without clinical signs of ankylosis, using the Osstell Mentor system. A cut-off implant stability quotient (ISQ) of 43 provided a specificity of 100% and a sensitivity of 53.3% when measured in the mesio-distal direction or a sensitivity of 20% when measured in the bucco-lingual direction. Based on a receiver-operating characteristic (ROC), the area under the curve (AUC) of 0.807 showed the mesio-distal direction of measurement to be a test of moderate discriminatory power. Given its non-invasiveness, RFA may serve as a quantitative diagnostic supplement to the clinical examination of potentially ankylosed primary molars.

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Key words: dental ankylosis; primary dentition; receiver operating characteristic; resonance frequency analysis; sensitivity and specificity

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Ankylosis is the result of an impaired periodontal ligament where cementum and dentin are resorbed and replaced by bone (1). The reported prevalence of ankylosed teeth ranges from 1.3 to 38.5% (2), depending on age, ethnic background, and the diagnostic tool (3). Mandibular primary molars have the highest incidence of ankylosis (4, 5), which occurs more commonly when the successional tooth is congenitally missing (3, 5–8). In patients with agenesis of permanent teeth, 40% of the persisting primary teeth appear infraoccluded (9) and up to 98% of the submerged teeth are ankylosed (10). Complications associated with ankylosis in the primary dentition are mostly related to this perceived intrusion (which is a result of the continuing vertical growth of the alveolar bone) (11), and include tipping of the adjacent dentition (12) and overeruption of the opposing dentition (1). Chewing function and the ability to maintain proper oral hygiene may also be impaired (13). Early detection of ankylosed teeth therefore helps to prevent treatment-intensive malocclusions in the changing dentition. In the permanent dentition, persisting primary teeth resist orthodontic movement (14, 15) and may be considered for absolute anchorage in treatment planning (16).

Diagnostic tools to determine ankylosis include tests on immobility and percussion. Ankylosed teeth render a clear and solid sound, which in healthy teeth is dampened by the intact periodontal ligament (17). For quantifying the mobility of ankylosed teeth, the Periotest

(Medizintechnik Gulden, Bernsheim, Germany) has been suggested (18). Radiography reveals ankylosed areas only when they are located on the proximal surfaces of the root; it is not possible to detect ankylosed areas on the lingual or labial surfaces using radiography (19). While three-dimensional imaging may be indicated in the most severe cases of submerged primary molars (12), concerns over radiation exposure would generally not vindicate computed tomography (CT) as a diagnostic tool for ankylosis.

Resonance frequency analysis (RFA) is a non-invasive and non-destructive measure of implant stability (20–22). Using this technique, the implant–bone interface is measured based on the resonance frequency (RF) as a reaction to oscillations exerted onto the implant bone contact point. The unit of measurement is defined as the implant stability quotient (ISQ) (23), ranging in integers from 1 to 100 and with higher values indicating higher implant stability (24). A commercially available RFA device, the Osstell Mentor, uses the detection of magnetic frequencies between the implant-mounted transducer (Smartpeg) and the handheld resonance frequency analyser to measure the ISQ (23). For the assessment of primary implant stability, RFA was shown to be a reliable tool (25), given that parameters such as the orientation of the transducer are controlled during *in vivo* resonance frequency measurements (26).

Osseointegration of dental implants can be considered as a functional ankylosis (27). Therefore, we hypothe-

# Relocation of Infrapositioned Ankylosed Teeth: Description of Orthodontic Bone Stretching and Case Series

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Different treatments have been proposed to manage the consequences of ankylosed teeth. This clinical report, which includes several different clinical conditions, describes an orthodontic bone-stretching procedure that can be used to relocate ankylosed teeth. The orthodontic bone-stretching technique involves only partial osteotomies, without the mobilization or repositioning of the alveolar segment, combined with orthodontic forces. The applied force facilitates tooth movement to the occlusal plane and can modify the axis of the ankylosed tooth. This relocation is possible because of a bone-stretching phenomenon in the surgical area. In all of the cases, relocation of the ankylosed teeth was successfully performed and the gingival margins were corrected to improve the esthetic results.

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Severe injuries of the periodontal ligament, frequently the permanent maxillary incisors in children, may lead to the ankylosis phenomenon, resulting in fusion between the mineralized root surface and the alveolar bone.<sup>1,2</sup> Such ankylosis disturbs dentoalveolar development during growth. In fact, an ankylosed tooth in a growing child does not erupt, resulting in a vertical insufficiency of osseous growth, which can lead to infraclusion, an unesthetic smile, and occlusal disharmony. Therefore, a patient with an ankylosed tooth might require treatment for infraclusion and alveolar bone deficiency.

Ankylosis is clinically diagnosed by acute sound percussion (tooth resounding like crystal) and lack of mobility in comparison with dull sound percussion and physiological mobility of the adjacent unaffected teeth (the periodontal ligament absorbs sound and allows mobility). A Periotest device (Siemens AG,

Bensheim, Germany) is an instrument for the quantification of tooth mobility and can be used to confirm ankylosis. An electronic tapping head percusses the teeth. Ankylosed teeth have a shorter contact time, resulting in lower Periotest values than those for intact or mobile teeth.<sup>3</sup> Ankylosis also can be discovered or confirmed during orthodontic treatment by tooth immobility under an applied orthodontic force. Moreover, ankylosis can be confirmed by radiographic evaluation, showing a lack of ligament space.

Several alternatives exist to treat the consequences of ankylosed teeth. The first solution is extraction of the ankylosed tooth. Rehabilitation can be conducted with a bridge, but periodontal surgery (gingival graft) might be necessary to improve the mucosal volume of the ridge.<sup>4</sup> Treatment using a dental implant also can be used after extraction. However, bone regeneration with grafting may be necessary for vertical and

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## Restorative Management of Severely Ankylosed Primary Molars

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### ABSTRACT

Severe dentoalveolar ankylosis is an etiological factor for malocclusion. When infra-occlusion occurs early, it progresses with time, leading to severe consequences in young children because of compensatory supra-eruption of the antagonist tooth and mesialization of adjacent teeth. Early diagnosis allows for interception of the problem and may prevent orthodontic treatment. The purpose of this manuscript is to report two cases of infraocclusion of primary mandibular second molars that were diagnosed early and were treated with composite resin crowns. The use of indirect composite restorations for ankylosed teeth is a good option for primary teeth with a moderate/severe degree of ankylosis. (J Dent Child 2015;82(1):X-XX)

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KEYWORDS: DENTAL ANKYLOSIS, COMPOSITE RESIN, DECIDUOUS TOOTH

**D**entoalveolar ankylosis can be defined as a condition in which the root cementum fuses with the surrounding alveolar bone. The periodontal ligament is substituted for bony tissue, causing immobility of the tooth, a condition that leads to alterations in the eruption process, due to infra-occlusion.<sup>1</sup>

Ankylosis rarely affects the permanent dentition, yet it affects eight to 14 percent of primary molars of six- to 11-year-old children.<sup>2-7</sup> In the most severe cases,

it causes malocclusion, delayed eruption and morphological alterations in premolars, and a tendency of impaction of the successor permanent tooth.<sup>6</sup> Mandibular primary molars are the teeth most frequently affected by ankylosis, but there is no conclusive information whether the first or second molar is the most commonly affected tooth.<sup>2,4,6-9</sup> There is no gender predilection.<sup>10</sup>

The etiology of ankylosis remains unknown, but some factors, such as genetic predisposition, excessive masticatory force, alteration in local metabolism, infection, chemical or thermal aggression, trauma, and tongue-thrust, have been attributed as causes.<sup>7-11</sup> Furthermore, its presence in siblings indicates genetic association.<sup>4,5,10,12</sup> The absence of the successor permanent tooth is also regarded as a possible cause of dentoalveolar ankylosis.<sup>13,14</sup>

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## Importance of root development in autotransplantations: a retrospective study of 137 teeth with a follow-up period varying from 1 week to 14 years

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**SUMMARY** The aim of the present study was to perform a retrospective study of autotransplanted teeth with a variable but individually maximized follow-up period in order to provide information on the long-term clinical outcome. The sample was obtained from patients who were treated at the University Hospitals KU-Leuven, Belgium, during the period 1996–2010. Of the total of 109 subjects (137 teeth), 98 patients were invited for recall, of whom 68 patients (87 teeth) responded positively. Eleven out of the 109 patients were excluded due to loss of the transplanted tooth. Although 41 patients had no re-examination visit, clinical and radiological data from all 109 subjects were included in the sample. The follow-up period varied from 1 week to 14.8 years, with a mean of 4.9 years. Transplanted teeth receiving orthodontic treatment had a lower risk of ankylosis and were less likely to fail. The risk of root resorption was lower for teeth with stages one-half to three-quarters of root length at the time of transplantation. Molars were more susceptible to ankylosis. Almost all teeth showed partial or full obliteration of the pulp. Absence of further root development was higher in donor teeth with root length stage less than one-half. Trans-alveolar transplantation was less successful. Autotransplantation can be a valid alternative method in young adolescents for replacing missing teeth because of agenesis or trauma. The optimal time to transplant is when the root has reached two-thirds to three-quarters of the final root length.

### Introduction

Treatment of children and adolescents with missing teeth is challenging. Growth and developmental changes in the oral region have to be taken into account. Treatment options include prosthetic replacement, orthodontic closure, and maintaining the deciduous tooth in case of agenesis. If a suitable donor tooth is available, autotransplantation is a viable option. In addition to congenitally missing or traumatized teeth that cannot be preserved, transplantation of impacted teeth to their normal position is another indication (trans-alveolar transplantation; Thomas *et al.*, 1998; Tsukiboshi, 2002).

Autotransplantation refers to the transfer of a tooth from one region in the mouth to another in the same individual, into an extraction site, or surgically prepared socket. It is a well-established surgical treatment option to substitute missing teeth and offers a valuable and aesthetic solution at low cost. In contrast to osseo-integrated implants, the transplanted tooth can offer the benefit of capacity for functional adaptation, preservation of the alveolar ridge, and potential for continued alveolar bone induction in growing children (Paulsen and Andreasen, 1998; Czochrowska *et al.*,

2002; Tsukiboshi, 2002; Zachrisson *et al.*, 2004). After successful surgery, the transplanted tooth usually recovers its proprioceptive function and normal periodontal ligament (Aslan *et al.*, 2010). Careful case selection (age, type of donor tooth, and root length), per-operative factors, such as surgical procedure, skill, and experience of the operator, and adequate immobilization influence the outcome of this procedure (Thomas *et al.*, 1998; Kallu *et al.*, 2005). The donor tooth should be expendable whereby no negative effects result from the change of its position in the arch or its potential future loss. A multidisciplinary approach and an accurate follow-up are essential for the survival of the tooth.

The purpose of the present retrospective study of autotransplanted teeth was to evaluate the effect of donor root development, donor tooth type, and orthodontic treatment on the overall success rates.

### Materials and methods

The sample for this study comprised patients who were treated at the University Hospitals, KU-Leuven, Belgium. Kallu *et al.* (2005) documented part of this consecutive

## Vertical alveolar growth in subjects with infraoccluded mandibular deciduous molars

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**Introduction:** Our objective was to compare vertical alveolar growth in areas adjacent to infraoccluded deciduous molars with growth in areas of deciduous molars and normal occlusion for a period of at least 1 year by using digital subtraction radiography. **Methods:** This case-control study included 40 pairs of panoramic radiographs of growing patients with infraoccluded deciduous molars and 40 pairs of radiographs of patients without infraoccluded deciduous molars. One radiograph at baseline was obtained at diagnosis, and the other at least 1 year later. The subjects and the controls were matched according to chronologic age and time interval between the 2 radiographs. The 2 groups were compared with regard to vertical alveolar growth and vertical tooth movement. Measurements were assessed by using nonparametric tests (Mann-Whitney and Friedman) and a multiple comparison test. Significance was set at 5%. **Results:** A statistically significant difference was observed between the groups with regard to vertical alveolar growth measured on the bone crest between the first permanent molars and second premolars. **Conclusions:** Vertical alveolar growth between the first permanent molar and the second premolar adjacent to the infraoccluded teeth was smaller than in areas adjacent to teeth with normal occlusion. (Am J Orthod Dentofacial Orthop 2012;141:81-6)

Dental ankylosis, also called teeth in infraocclusion, is commonly found in deciduous and transitional dentitions, with a prevalence ranging from 8% to 14% in patients aged 6 to 11 years; severity is usually mild (61.3%) or moderate (30.4%).<sup>1-5</sup> Deciduous teeth are more commonly affected than permanent teeth, especially the first and second deciduous molars.<sup>4-7</sup>

When there is infraocclusion, growth and development of the alveolar bone are affected, with a consequent reduction in bone height, thus precluding eruption of the affected tooth that remains in infraocclusion.<sup>8,9</sup> Early diagnosis of the infraocclusion is essential for the establishment of effective preventive measures or treatment planning, including invasive procedures, always associated with adequate follow-up.<sup>4</sup>

Radiographic investigation is often recognized as an important diagnostic method in the follow-up of patients with infraoccluded teeth. It allows detection of an ankylosed area based on the absence of continuity of the periodontal ligament in the region where the cementum fuses with the alveolar bone.<sup>10,11</sup> Moreover, digital subtraction of panoramic radiographs has been successfully used to evaluate the behavior of implants, periapical lesions, and condylar alterations. This method allows evaluation of small changes by the superimposition of 2 radiographs, as shown in previous studies.<sup>12-15</sup>

No scientific evidence or research data are available confirming the relationship between infraocclusion of deciduous molars and vertical alveolar growth abnormalities in areas adjacent to the affected teeth. Therefore, the objective of this study was to compare vertical alveolar growth in areas adjacent to infraoccluded deciduous molars with areas of deciduous molars with normal occlusion for at least 1 year, based on measurements obtained with digital subtraction radiography.

### MATERIAL AND METHODS

The study protocol was approved by the Research Ethics Committee at Universidade Federal do Rio Grande do Sul in Brazil (protocol number 05/08). Pairs of panoramic radiographs of 80 patients in the transitional

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# Prevalencia de infraoclusión en molares primarios de niños de 7 y 8 años, Valdivia, Chile, 2019

*Prevalence of infraocclusion in primary molars of children aged 7 and 8, Valdivia, Chile, 2019*

*Prevalência de infraoclusão em molares decíduos de crianças de 7 e 8 anos, Valdivia, Chile, 2019*

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## Resumen

**Objetivo:** Determinar la prevalencia de infraoclusión en molares primarios de niños de 7 y 8 años, Valdivia, Chile.

**Materiales y métodos:** Estudio descriptivo de corte transversal. Se examinaron niños de 7 y 8 años en establecimientos educacionales de Valdivia. Fue evaluada la presencia y severidad de infraoclusión en molares primarios utilizando la clasificación de Brearley & McKibben. Para establecer diferencias estadísticas entre sexo y presencia de infraoclusión fue realizada la prueba de chi-cuadrado. Además un análisis de ANOVA fue utilizado para establecer diferencias entre la localización de la infraoclusión y el grado de severidad. El nivel de significancia estadística se estableció con un valor de  $p < 0,05$ .

**Resultados:** Fueron evaluados 359 niños y un 41,78% presentó infraoclusión. Según grado de severidad, 82,06% fueron leves, 15,28% moderadas y 2,66% severas. No se encontraron diferencias significativas entre sexo y presencia de infraoclusión. Se evidenciaron diferencias estadísticamente significativas al evaluar localización y grado de severidad ( $p < 0,05$ ).

**Conclusión:** Existe una alta prevalencia de infraoclusión en niños de 7 y 8 años en Valdivia, Chile.

**Palabras clave:** infraoclusión, diente anquilosado, molares primarios, prevalencia.

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# Ankylosed permanent teeth: incidence, etiology and guidelines for clinical management

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## Abstract

Ankylosis is a condition of direct root surface fusion with the encompassing alveolar bone. Depending on the patient's growth rate and bone metabolism, it is usually accompanied by progressive replacement resorption of the root and infraocclusion of the crown. Treatment options for ankylosed teeth depend on the development of the patient, severity of the malocclusion, and size of residual root. The prognosis of ankylosed teeth undergoing significant replacement resorption is hopeless, and should be replaced with an implant prosthesis. Treatment modalities include decoronation, direct or fixed build-up of the affected tooth, or various surgical interventions, when appropriately indicated.

## Introduction

Ankylosis might be one of the most prevalent causes for infraocclusion in the permanent dentition. Ankylosis in Greek means "lack of mobility". The term can refer to joints as well as teeth. From a clinical point of view, and based on our experience and reports by others, ankylosed teeth may still have some degree of mobility in spite of the literal name [1]. By histological means, ankylosis of teeth is defined as the fusion of the root surface (either cementum or dentin) with the surrounding alveolar bone. There is some confusion between the term ankylosis and other terms used to describe its consequences, such as infraocclusion, meaning a tooth not reaching the occlusal plane [2], submergence, impaction, and incomplete eruption.

Replacement resorption is a process of physiological remodeling of bone and erroneously the adjacent root cementum and/or dentin, which results in replacement of the root with bone tissue. Replacement resorption usually accompanies ankylosis, therefore leading to the confusion of the two phenomena in terms of diagnosis. In order to differentiate between the two different terms, one should refer to ankylosis in diagnostic terms, so that when a tooth is proven as ankylosed, the clinician should anticipate and radiographically look for replacement resorption as a progressive process accompanying ankylosis and compromising the tooth prognosis.

## Mechanism

In mechanistic terms, ankylosis and replacement resorption should not be interchanged with external root resorption, which is an inflammatory-mediated process that necessitates the continuous presence of infectious stimuli through the pulp and can be reversed by elimination of the stimuli [3,4]. Tronstad described the initiation of ankylosis following extensive necrosis of the periodontal ligament along with formation of bone that invades the denuded root surface area. Tronstad claimed that involvement of dental trauma (luxation) is the primary reason for this injury, particularly avulsion of teeth and their presence in a dry environment for a critical time, which causes

cell death on the root surface. The minimum injured root surface area leading to ankylosis as reported by Andersson is 20% [1]. This suggests a healing capacity of the periodontal ligament and surface cementum that can overcome the injury and allow for reattachment of periodontal ligament fibers if the affected area is less than 20% of the root surface [5,6]. Following tooth luxation, injury to root surface due to mechanical trauma occurs in variable degrees, forms, and distribution. Diffuse damage involving more than 20% of the root surface area is followed by a reactive inflammatory response that initiates the healing process. The result is an area of cementum-devoid root surface that is now susceptible to migration and repopulation by the faster bone forming cells rather than by the slower periodontal ligament fibroblasts or cementoblasts. This leads to a root surface area lined with cells of the osteoblastic lineage, that deposit bone in direct contact with the root surface, resulting in direct connection between the two tissues [7]. At this point, the root has become ankylosed, but replacement resorption is yet to take place. The root now becomes part of the bone tissue and therefore osteoclasts and osteoblasts replace its tissues with bone in a progressive non-inflammatory remodeling process, thus named replacement resorption. It is important to emphasize that replacement resorption is observed in either vital teeth with normal pulp tissue or in pulpless teeth with no infectious stimulus through the root canal. The presence of infectious stimuli, such as bacterial endotoxins, that pass from the root canal to the external root surface through the dentinal tubuli and accessory canals induces inflammation-mediated resorption of the root tissues and probably adjacent bone, in attempt to eliminate infectious elements<sup>3</sup>. Another major difference between replacement

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## Persistence of deciduous molars in subjects with agenesis of the second premolars

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**SUMMARY** The purpose of the present study was to investigate persistent primary second molars in a group of young people in their late twenties with agenesis of one or two second premolars.

In 1982–83 it was decided, in connection with the orthodontic evaluation of 25 patients, to allow 35 primary molars (one or two in each patient) to remain *in situ*. All patients had mixed dentitions and agenesis of one or two premolars. The primary teeth were generally in good condition, although root resorption and infra-occlusion (compensated by occlusal composite onlays) occurred.

In 1997, 18 of the 25 patients with a total of 26 retained primary molars were re-examined, comprising a clinical examination for exfoliation, extraction, loosening, and ankylosis, and a radiographic examination for root resorption, tooth morphology (crown and root), and alveolar bone contour.

The examination showed that the degree of root resorption was unaltered in 20 of the 26 primary molars. In the permanent dentitions, where these primary molars persisted, there were no morphological deviations. Three of the six remaining primary molars had been extracted and three showed extensive resorption. In three of the 26 primary molars the infra-occlusion had worsened.

The present study shows that persistence of primary second molars in subjects with agenesis of one or two premolars, and normal morphology of the permanent dentition can be an acceptable, semi-permanent solution for the patient. Whether this could also be an acceptable long-term solution will be shown by follow-up studies.

### Introduction

In subjects with agenesis of one or two premolars, dependent on the occlusion, jaw relationship, and jaw growth, it is not unusual to extract the primary teeth in the region concerned prior to orthodontic treatment. The general view is that the roots of the primary teeth gradually resorb, even in those regions where there are no successional teeth. There are, however, no studies that show whether the primary teeth always resorb and under what conditions the primary teeth may possibly persist, with or without minor root resorption.

An earlier study showed that there is agreement between the tendency to resorption in the primary and permanent dentitions in the

same individual. That investigation also showed that root resorption due to orthodontic treatment with fixed appliances occurred in dentitions with minor root and crown abnormality (Kjær, 1995). Another result was that patients with morphological abnormalities in the permanent dentition often had an abnormal pattern of resorption in the primary dentition. Accordingly, individual tendency to resorption occurred in both dentitions and deviant morphology in the permanent dentition was often seen in patients with a tendency to root resorption (Kjær, 1995).

In connection with agenesis of permanent teeth, it is inadvisable to undertake extractions in certain types of malocclusion. This applies, for

## CASE REPORT

## Submerged and Impacted Primary Molars

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### Abstract

Submerged tooth is the one that is depressed below the occlusal plane. Dental ankylosis is thought to be a major cause of submergence. Submerged deciduous teeth have the potential to cause malocclusion not only by prevention of their exfoliation and subsequent replacement by permanent teeth but also by causing tilting of proximal teeth and extrusion of opposing tooth. The purpose of this report is to present three different cases of submerged deciduous teeth and their clinical effects.

**Keywords :** Submerged, Deciduous, Ankylosed.

### INTRODUCTION

Submerged deciduous teeth means the affected teeth do not come to the level of adjacent normal occluding teeth or submerged teeth are always 0.5 mm or more below the intact marginal ridges of the adjacent teeth.<sup>1</sup> This incidence occurs after eruption/emergence of teeth in the oral cavity.

Trauma is the most common cause damaging either the dental follicle or the developing periodontal ligament but the exact etiology is unknown. If it happens then the eruption of the tooth ceases and it becomes ankylosed in the jaw bone. Because of continued eruption of the neighboring teeth and increase in the height of alveolar bone, the ankylosed tooth may be either "shortened" or submerged in the alveolar bone.

The prevalence of submerged deciduous teeth in children varies from 1.3 to 3.5%. The most commonly affected teeth are the deciduous mandibular second molars.<sup>2-4</sup> This process prevents their exfoliation.

### CASE 1

A 9-year-old boy came to the dental OPD of ZA Dental College, AMU, Aligarh (UP), India with a complaint

of cheek bite on his left side. On examination, the left mandibular deciduous second molar was absent and the permanent mandibular left 1st molar was mesially tilted along with supra-eruption of maxillary left deciduous second molar resulting in disturbed occlusion, responsible for cheek bite and ulceration.

Panoramic radiograph demonstrated that deciduous second molar was submerged and there was severe tilting of permanent mandibular 1st molar (Fig. 1). Hence, early removal of the deciduous molar was planned in order to prevent the development of malocclusion in the future.

The tooth has to be removed carefully while saving the erupting permanent 2nd premolar.

### CASE 2

A 9-year-old boy came to the OPD of ZA Dental College, AMU, Aligarh with a complaint of carious upper tooth and missing lower posterior teeth.

On clinical examination, it was found that there was caries in the upper left deciduous second molar and the lower deciduous second molars along with the permanent first molars were absent. An OPG was advised.

# Review: Treatment strategies for ankylosed primary molars

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## Abstract

**AIM:** The purpose of this article is to focus on aetiology and appropriate treatment techniques concerning ankylosis of primary molars. **LITERATURE:** The dental literature is reviewed in detail concerning aetiology, frequency of occurrence, diagnosis and longevity of ankylosed primary molars without successors. Treatment concepts are discussed. Long term implications of treatment decisions made in the mixed dentition are emphasised. Areas of treatment that are unsupported by evidence are identified as potential research topics. **CONCLUSION:** When the underlying premolar is present and the infra-occlusion is not progressive, then observation is appropriate. Only when there is severe disruption to the occlusion and/or the underlying premolar, extraction and space management may be appropriate. When the ankylosed primary molar has no underlying premolar, orthodontic input is needed to determine if extraction and space closure, extraction and transplantation or extraction and prosthetic replacement is the best plan.

## Introduction

The ankylosed infra-erupted primary tooth has stopped its vertical movement relative to others along the occlusal plane such that marginal ridges are not at the same height as adjacent teeth [Noble et al., 2007]. Frequently such infra-erupted teeth are identified as ankylosed and clinically appear submerged [Kuroi, 1984]. This implies that the tooth was at the correct level and has subsequently submerged. In reality, the adjacent teeth are erupting while the affected ankylosed tooth is maintaining its position because of root cementum fusion to the alveolar bone. This infra-occlusion has the potential to cause significant occlusal problems. Since Kuroi's thesis on infra-erupted teeth [1984] there has been little new research. The purpose of this article is to focus on appropriate treatment techniques after briefly reviewing the aetiology, frequency and diagnosis; readers are referred to Teague et al., [1999a, 1999b] and Sabri [2008] for further review. Long term implications of treatment decisions made in the mixed dentition will be emphasised. Areas of treatment that are unsupported by evidence will be identified as potential research topics.

## Aetiology

The true aetiology of ankylosed primary molar teeth remains unknown although trauma and genetics may be significant factors [Kuroi, 1984]. The high frequency of ankylosis in reimplanted avulsed incisors together with traumatically induced ankylosis in experimental animals suggests that trauma to the periodontal membrane may be an aetiological factor. This traumatic disruption to the periodontal membrane may result in fusion of the root cementum to the adjacent alveolar bone. The higher frequency of infra-erupted teeth in siblings supports a genetic aetiology [Kuroi, 1981]. Also, children with one infra-erupted tooth frequently show other teeth that subsequently present with infra-eruption [Brearley and McKibben, 1973]; this, in conjunction with the correlation of ankylosed primary molars and other dental anomalies [Baccetti 1998, Bjerkin et al., 1992 Garib et al., 2009], also supports a genetic aetiology.

## Frequency

The reported frequency of ankylosed infra-erupted teeth ranges from 1.3 to 38.5% and varies according to age [Kuroi, 1981; Steigman et al., 1973]. In the primary dentition, the mandibular first primary molar is the most commonly affected tooth [Steigman et al., 1973]. The most common presentation is in the middle mixed dentition stage of development with second primary molars being more affected than the first primary molars [Biederman, 1962]; the mandible demonstrates a higher prevalence of ankylosed primary molars compared with the maxilla [Biederman, 1962].

There appears to be two kinds of ankylosed teeth. One demonstrates absence of progressive infraocclusion and self-resolution with slight delay in eruption [Kuroi and Thilander, 1984a]. In the other type, infraocclusion deteriorates with increasing age which can create greater consequence in young children because there will be increased vertical compensatory eruption of adjacent teeth during continued growth to magnify the submergence. Therefore the potential impact is much less on a skeletally mature 12-year-old girl with an ankylosed retained primary molar than on a pre-adolescent 9-year-old male with a similar tooth who has yet to undergo his adolescent growth spurt.

**Key words:** ankylosis, primary molars, infra-eruption, treatment

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## Original Article

# Autotransplantation of Teeth in 215 Patients

### A Follow-up Study

Sven Kvint<sup>a</sup>; Rune Lindsten<sup>b</sup>; Anders Magnusson<sup>c</sup>; Peter Nilsson<sup>d</sup>; Krister Bjerklin<sup>e</sup>

#### ABSTRACT

**Objective:** To evaluate the success rate of autotransplantation of teeth in consecutive patients and to analyze factors affecting the outcome.

**Materials and Methods:** The subjects consisted of 215 consecutive patients (101 women and 114 men; aged 9.1–56.4 years, median age 15.2 years [ $P_{10} = 11.4$ ,  $P_{90} = 19.7$ ]) who had undergone transplantation of a total of 269 teeth, all by the same surgeon. In patients with multiple transplants, only the first transplant was included, to ensure that all transplanted teeth were independent units. The transplants were recorded as unsuccessful if the tooth had been extracted or was surviving but with root resorption or ankylosis. The interval between transplantation and final follow-up was a median 4.8 years ( $P_{10} = 2.0$ ,  $P_{90} = 5.5$ ) for successful transplants and a median of 2.4 years ( $P_{10} = 0.4$ ,  $P_{90} = 7.7$ ) for unsuccessful transplants.

**Results:** One-hundred seventy-five (81%) of the transplantations were recorded as successful and 40 (19%) as unsuccessful. Twenty-five teeth had been extracted and 15 had survived but did not fulfill the criteria for success.

**Conclusions:** The success rate of 215 consecutively transplanted teeth was 81%. The highest success rate was for transplantation of premolars to the maxillary incisor region (100%). Complications at surgery such as difficult extraction, deviant root anatomy, or damaged root periodontium affected the outcome. During growth, a successful transplant preserves alveolar bone. (*Angle Orthod.* 2010;80:446–451.)

**KEY WORDS:** Tooth transplantation; Follow-up; Oral surgery; Orthodontics

#### INTRODUCTION

Autogenous tooth transplantation is a well-established surgical treatment. Successful autotransplantation of immature mandibular third molars was reported

by Fong as early as 1953.<sup>1</sup> A method for autotransplantation of immature premolars was described in 1967 and 1974 by Slagvold and Bjerkce.<sup>2,3</sup> High initial success rates<sup>2,4–7</sup> and also long-term results are reported.<sup>7–10</sup>

The most common complications associated with autotransplanted teeth are ankylosis and root resorption. Many factors influence the result, such as the developmental stage of the tooth, donor type, the duration of extraoral exposure of the donor tooth during surgery, damage to the root cementum and the periodontal ligament, and the experience of the oral surgeon.<sup>10,11</sup>

The application of different criteria for success has an impact on the reported figures. The success rate is reported to be higher than 80% when the root length of the autotransplanted premolar is 50% to 75% of the normal root length at the time of the surgery.<sup>2,4,6,10,12,13</sup> Lagerström and Kristerson<sup>14</sup> reported maintenance of at least 70% of the final root length to be a criterion for successful outcome.

The aim of the present investigation was to evaluate the success rate of autotransplantation of teeth in a

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# Late diagnosis of dentoalveolar ankylosis: Impact on effectiveness and efficiency of orthodontic treatment

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Dentoalveolar ankylosis is a local etiologic factor of malocclusion that can have deleterious effects on normal dental development. Therefore, it is of paramount importance to diagnose the problem as early as possible so that interception can be performed at the correct time. This case report demonstrates the consequences of late diagnosis of dentoalveolar ankylosis and discusses its effects on development of the occlusion and how it can increase orthodontic biomechanical complexity and treatment time. (*Am J Orthod Dentofacial Orthop* 2009;135:799-808)

**D**entoalveolar ankylosis is an eruption anomaly defined as the union of the tooth root to the alveolar bone, with local elimination of the periodontal ligament. This condition can result in replacement root resorption, in which the root is substituted by bone.<sup>1</sup>

Dentoalveolar ankylosis has been described as a local factor of malocclusion.<sup>2-4</sup> Its cause is not well defined, but it can be associated with dental trauma,<sup>5-7</sup> metabolic disturbance,<sup>5,7</sup> a genetic tendency, or a local deficiency in vertical bone growth.<sup>5</sup>

According to Biederman<sup>7</sup> and Moyers,<sup>2</sup> ankylosis in deciduous teeth is about 10 times more likely than in the permanent dentition, and twice as likely in the mandibular than in maxillary arch. A higher incidence can be observed in the molar region during the deciduous and mixed dentition. The incidence of deciduous-tooth dentoalveolar ankylosis was reported to be 1.5% to 9.9%.<sup>8</sup>

When dental ankylosis occurs early, it is more likely to have a deleterious impact on the occlusion.<sup>7,9</sup> The most common consequences are progressive infraocclusion of the ankylosed teeth, inclination of adjacent teeth, bone defects, and impaction of the succeeding perma-

nent teeth or eruption delay.<sup>9</sup> Becker and Karnei-R'em<sup>10-12</sup> also added midline shift to the ankylosed side and extrusion of the antagonist tooth, increasing the risk of occlusion problems.

Kofod et al<sup>6</sup> pointed out that, in a growing child, the ankylosed tooth does not follow the normal vertical growth of the alveolar process, and a deficiency occurs, causing the tooth to be even more impacted.

Diagnosis of dental ankylosis is generally established through clinical findings, but radiographs can sometimes add some information. As suggested by Mullally et al,<sup>8</sup> although a clinical diagnosis can be made by infraocclusion, percussion, and mobility testing, sometimes lack of orthodontic movement can confirm the diagnosis.

Since dentoalveolar ankylosis can cause deleterious effects on occlusal development, early diagnosis and an effective treatment plan are fundamental to prevent further eruption deviations and more severe malocclusion.

Our aim in this article was to present a patient in the mixed dentition with dentoalveolar ankylosis of a deciduous molar in which the diagnosis was not made at the correct time, resulting in a severe malocclusion. As a result, when the diagnosis was established, longer and more complex treatment was necessary. Although the treatment was effective, it was not efficient because of its long duration and biomechanical complexity, caused by the late diagnosis.

## DIAGNOSIS AND ETIOLOGY

A boy, aged 9 years 10 months, of mixed ethnic background (black and white), was referred to the orthodontic clinic of the School of Dentistry of the Pontifícia Universidade Católica de Minas Gerais in Brazil. His chief complaints were absence of a mandibular

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## A novel approach for building up infraoccluded ankylosed primary molars in cases of missing premolars: A case report

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### Abstract

**Background** In cases of infraoccluded primary molars associated with agenesis of premolars, any treatment plan occasionally includes retention of the primary teeth for space preservation and future implant placement if needed. In these cases, building up the crowns to the occlusal line is necessary to prevent various clinical problems. The present case report describes in detail a novel but simple clinical approach for retention and building up of the crown of infraoccluded primary molars.

**Case report/technique presentation** The technique is presented in a 14-year-old girl with nine missing permanent teeth. Orthodontic evaluation indicated space closure for five teeth and space maintenance in the remaining four second primary molars, three of them being infraoccluded. The technique included the following clinical steps: (a) elastic separators were placed proximally to the primary molars for few days to create space; (b) proximal minimal reduction of the crown width was performed; a direct hand composite resin core was made to increase crown height facilitating the selection of a preformed metal crown (PMC). The selected PMC was filled with self-curing composite resin and placed on the primary tooth following an acid etch and adhesive procedure; excess cervical material was removed; (c) after polymerisation, the PMC was carefully removed using cutting and hand instruments, revealing the composite resin fabricated crown which was adjusted for occlusion and polished. Radiographic evaluation confirmed the result.

**Conclusion** This simple method for infraoccluded primary molars crown building up to occlusion using conventional instruments and materials, appears to be a valuable clinical tool for paediatric dentists who frequently find themselves dealing with primary teeth that need to be retained and which can produce serious clinical problems if left untreated.

**Keywords** Infraocclusion · Ankylosis · Primary molars · Built-up · Treatment

### Background

In clinical practice, paediatric dentists are frequently asked to deal with young patients with infraoccluded second primary molars associated with congenitally missing premolars. Although in these cases the extraction of the primary teeth and orthodontic space closure is usually recommended by orthodontists (Sabri 2008), there are certain cases where the treatment plan includes their maintenance and future implant placement, when and if they finally exfoliate (Kennedy 2009; McGeown and O'Connell 2014).

In these cases and during their maintenance period, infraoccluded primary molars may present serious clinical problems concerning the occlusion and the local dental and periodontal health that need to be prevented and/or treated. Previous reports have proposed a number of restorative and prosthetic techniques aiming to build up crowns of the infraoccluded primary molars to the occlusal line (Kennedy 2009). However, the majority of them require laboratory assistance and increased effort and time by the clinician.

The present case report/technique presentation describes in detail a novel simple clinical approach for a simple

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# L'ankylose dentaire : diagnostic par tomodensitométrie et reconstruction tridimensionnelle

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## Dental ankylosis diagnosed by CT with tridimensional reconstructions

The etiology of unerupted teeth often is difficult to establish. It may relate to abnormal orientation of the tooth bud, an anatomical obstacle, pathology of the dental sac or ankylosis. The ankylosis process and diagnosis are analyzed in this clinical series. Ankylosis and its underlying physiological process are abundantly described in the literature. Nonetheless, diagnosis remains difficult to achieve. Clinical evaluation and complementary radiographic techniques such as dental radiographs and orthopantomogram are considered by some authors as poorly reliable. These clinical examinations based on a series of subjective criteria cannot be performed on unerupted

## Case Report

# Management of a Severely Submerged Primary Molar: A Case Report

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Ankylosis is a condition frequently associated with primary molars, wherein the ankylosed primary teeth remain in a fixed position, while the adjacent teeth continue to erupt, moving occlusally. In this case report, a five-year-old boy, who had a retained and submerged left lower second primary molar, was presented. Luxation of ankylosed primary molar was considered as a treatment approach. After four months, the tooth erupted to the occlusal level, and there was evidence of further development of a permanent successor in radiographic evaluation. After one year, tooth mobility, bone formation, and development of a permanent successor were in good condition.

## 1. Introduction

*Dental infraocclusion* is defined as teeth below the occlusal plane. In the literature, the terms submergence and infraocclusion are often used to refer to an ankylosis [1, 2].

The frequency of ankylosed teeth has been reported to be between 1.3% and 38.5% [3]. The mandibular first primary molars are the most frequently affected teeth, followed by second mandibular and maxillary primary molars [3].

The exact cause of teeth ankylosis is still unknown, but several theories have been proposed [3, 4] such as familial pattern, traumatic injury to Hertwig's epithelial root sheath, deficiency in bone growth, a problem in local metabolism and inflammation, localized infection, and chemical or thermal irritations.

Ankylosis is classified as slight, moderate, or severe according to the place of the occlusal level of the infraoccluded tooth [5]. If the infraocclusion is less than 2 mm, it shows slight ankylosis, while moderate submergence shows the occlusal surface of the ankylosed tooth to the contact area. Severe ankylosis shows infraocclusion below the contact area of the adjacent teeth [5].

Diagnosing ankylosed teeth is not difficult and is usually based on clinical signs and radiographic findings. Clinically,

ankylosed teeth have a sharp, solid sound on a percussion test in comparison to a cushion sound in normal teeth [2].

Obliteration of the periodontal ligament space is noted radiographically. The roots are less radiopaque, and as the ankylosis progresses, they are less distinguished from surrounding bone. Areas of fusion of cementum and bone, as well as periodontal ligament remnants that are fibrotic with very few cells, have been observed histologically. No mucopolysaccharidase activity, which is essential for the normal process of root resorption during eruption of permanent successor, is seen [6].

Ankylosis of deciduous molars has a negative impact on normal occlusal development and may cause problems such as

- (a) significant tipping of adjacent teeth to the area of the submerged tooth, which may cause a reduction in arch length, especially when severe ankylosis of second primary molars occurs in early mixed dentition [5, 7];
- (b) ectopic eruption or impaction of successor premolar;
- (c) The increase in caries and periodontal disease susceptibility [3].



## CASE REPORT

## Decoronation as an alternative procedure for dental ankylosis after dental reimplantation due to trauma in a growing child: case report

Decoronação como procedimento alternativo para anquilose dentária após reimplante dental devido a trauma em crianças em crescimento: relato de caso.

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### ABSTRACT

Dental ankylosis occurs by fusion of the root surface with the alveolar bone due to necrosis of the periodontal ligament. Although there is not a known treatment for dentoalveolar ankylosis, there are alternative procedures that may be realized as a way to prevent serious consequences. Decoronation is a procedure which the crown of the ankylosed tooth is surgically removed below the cemento-enamel junction and the root is buried. Our aim is to report the case of patient LSM, female, 8 years-old, who came to the Oral Dental Trauma Center of Federal University of Ceará after colliding against a wall. Avulsion of the dental element 21 occurred and the tooth was stored in milk. The reimplantation occurred one hour after the injury. After two years of the dental trauma, the treatment performed was decoronation and installation of an aesthetic and functional space maintainer. This case report presents a clinical and radiographic follow-up of 6 months and 3 years. In the 6-month evaluation, the buried root showed signs of resorption, but without bone loss, the aesthetic space maintainer was still well adapted and the alveolar ridge have no signals of gingival or bony issues. After three years, radiographic evaluation showed complete root resorption and signs bone formation in root previous site. Decoronation is a procedure that aim to maintain the alveolar bone ridge width, height and continuity and may be indicated to dental ankylosis, being a successful procedure in the reported case, allowing the patient to maintain the aesthetic, function and preserve the alveolar process to a future reahabilitation.

### KEYWORDS

Tooth Ankylosis, Tooth avulsion; Tooth injuries.

### RESUMO

A anquilose dentária ocorre por meio da fusão de superfície da raiz com o osso alveolar, devido à necrose do ligamento periodontal. Trauma local, infecção periapical, desordens endócrinas e metabólicas, esforço mastigatório excessivo, falta de força eruptiva do sucessor permanente e alterações genéticas são alguns dos fatores que podem levar a anquilose. Embora não haja um tratamento conhecido para anquilose dentoalveolar, existem procedimentos alternativos, tais como manter o dente anquilosado ou sua raiz, extração seguida de fechamento ortodôntico, autotransplante, implante, osteotomia da unidade dento-óssea ou decoronação. A decoronação é um procedimento em que a coroa do dente anquilosado é removido cirurgicamente abaixo da junção cimento-esmalte e a raiz é sepultada. Após o procedimento, mantenedor de espaço estético-funcional é instalado para evitar a perda de espaço até a oportunidade de proporcionar um tratamento de reabilitação definitiva. Nosso objetivo é relatar o caso de paciente LSM, fêmea, 8 anos de idade, que se apresentou para o Centro de Trauma Bucodentário da Universidade Federal do Ceará após colidir contra uma parede. Avulsão do elemento dentário 21 ocorreu e o dente foi armazenado em leite. O reimplante ocorreu uma hora após a injúria. O tratamento realizado foi decoronação e instalação de um mantenedor de espaço estético e funcional. Este relato de caso apresenta um acompanhamento clínico de 6 meses e 3 anos de acompanhamento radiográfico.

### PALAVRAS-CHAVE

Anquilose dental; Avulsão dentária; Traumatismos dentários

## Congenital agenesis of premolars associated with submerged primary molars and a peg-shaped lateral incisor: A case report

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The combination of infraoccluded primary molars and agenesis of the permanent successors is rare. This condition progresses with increased severity since the primary teeth do not usually exfoliate spontaneously. The clinical examination of an 11-year-old girl revealed 4 submerged primary second molars, agenesis of all second premolars, and a peg-shaped maxillary lateral incisor. Treatment in this case was surgical extraction of the submerged teeth and placement of removable appliances to maintain space and vertical dimension. (*Quintessence Int* 2007;38:435–438)

**Key words:** agenesis, ankylosis, infraocclusion, peg-shaped tooth, primary teeth, removable appliance, surgical treatment

Tooth agenesis of permanent teeth is the most common developmental dental anomaly. It is genetically determined with autosomal-dominant transmission and is associated with several other dental abnormalities.<sup>1,2</sup> The prevalence of agenesis varies from 5% to 10%, excluding third molars, and it occurs mostly in second premolars and maxillary lateral incisors.<sup>1,3–5</sup> Researchers have indicated a relationship of 17% between agenesis and infraocclusion of primary molars<sup>6,7</sup> as well as a relationship between agenesis and peg-shaped maxillary lateral incisors.<sup>8</sup>

Ankylosis is a well-established condition associated with infraocclusion of primary molars.<sup>9,10</sup> It involves fusion of cementum to alveolar bone, affects almost all infraoccluded

primary molars, and may subsequently develop into infraocclusion, often at a microscopic level; any obliteration of the periodontal ligament may remain undetected in conventional radiographs.<sup>11</sup> The mechanism of ankylosis initiation is unknown,<sup>12</sup> but it is probably due to developmental disturbances in the periodontium.<sup>10</sup> Furthermore, changes in the distribution of epithelial cell rests of Malassez in the periodontium of ankylosed primary molars are etiologically relevant to subsequent root resorption and ankylosis.<sup>13</sup> The combination of the absence of a permanent successor and infraocclusion of primary molars might affect not only alveolar bone growth, which stops in the submerged area, but also occlusal disturbances such as mesial tipping of the permanent first molar.<sup>21</sup> Thus, whenever a tooth is congenitally missing, an early diagnosis is vital to provide adequate treatment and to prevent malocclusion, particularly if agenesis occurs in association with another dental defect.<sup>2</sup>

The following report describes the management of a patient with agenesis, ankylosis, infraocclusion, and a peg-shaped tooth.

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# Management of ankylosed primary molars with premolar successors

## A systematic review

Long D. Tieu, DDS, MSc; Stephanie L. Walker, DDS, BSc; Michael P. Major, DM, BSc; Carlos Flores-Mir, DDS, DSc, FRCD(C)

**D**uring a child's normal growth and development, teeth continually erupt vertically until they contact in occlusion. The general practitioner frequently is the first to encounter developmental anomalies such as infraocclusion. It is relatively common to find an infraerupted primary molar that has stopped erupting vertically, resulting in marginal ridge discrepancies with adjacent teeth. In this scenario, vertical growth of the adjacent teeth and alveolar processes continues; however, the affected tooth experiences lack of alveolar bone growth resulting from its arrested eruption.<sup>1</sup> Ankylosed primary molars affect occlusal development by complicating eruption and development of the permanent dentition. Among the complications, distal eruption of the second premolar is frequent, and a hooked or altered radicular shape of the premolar underlying the ankylosed primary molar has been reported,<sup>2</sup> possibly

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## ABSTRACT

**Background.** The authors conducted a systematic review to determine the clinical prognosis of and methods of managing ankylosed primary molars with permanent successors.

**Methods.** The authors searched electronic databases (PubMed, Scopus, MEDLINE, Cumulative Index to Nursing and Allied Health Literature, Web of Science, Cochrane Database of Systematic Reviews and Google Scholar) up to April 2012 with the assistance of a librarian specializing in health sciences databases. They also searched the gray literature. They selected clinical studies in which investigators assessed the prognosis of ankylosed primary molars with permanent successors; they also hand searched references of the selected articles to identify any additional studies that the electronic search may have missed.

**Results.** The authors identified 3,529 original articles from the electronic database search and none from the hand search. Once selection criteria were applied, only four articles met all inclusion criteria and were included. The number of patients studied ranged from 15 to 107. The number of ankylosed primary molars investigated ranged from 26 to 263.

**Conclusions.** Ankylosed primary molars often manifest with mild to moderate progressive infraocclusion. Conservative monitoring of ankylosed primary molars is recommended. The clinician should consider extraction if the permanent successor has an altered path of eruption, if the ankylosed primary molar is severely infraoccluded with the adjacent teeth tipping to prevent the successor from erupting, or both. The ankylosed molar often exfoliates spontaneously within six months; however, when exfoliation is more delayed, arch-length loss, occlusal disturbance, hooked roots or impaction of permanent successors may occur.

**Practical Implications.** Ankylosed primary molars initially should be monitored closely for up to six months. If they do not exfoliate spontaneously, they should be removed, because arch-length loss, alveolar bone defects, impacted permanent successors and occlusal disturbances often occur when the removal is delayed.

**Key Words.** Dentition; decision making; dental arch; dental care for children; ankylosis.

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## ARTICLE OPEN

# Transcriptome analysis of ankylosed primary molars with infraocclusion

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Primary molar ankylosis with infraocclusion can retard dental arch development and cause dental asymmetry. Despite its widespread prevalence, little is known about its molecular etiology and pathogenesis. To address this, RNA sequencing was used to generate transcriptomes of furcal bone from infraoccluded ( $n = 7$ ) and non-infraoccluded ( $n = 9$ ) primary second molars, all without succeeding bicuspid. Of the 18 529 expressed genes, 432 (2.3%) genes were differentially expressed between the two groups (false discovery rate  $< 0.05$ ). Hierarchical clustering and principal component analysis showed clear separation in gene expression between infraoccluded and non-infraoccluded samples. Pathway analyses indicated that molar ankylosis is associated with the expression of genes consistent with the cellular inflammatory response and epithelial cell turnover. Independent validation using six expressed genes by immunohistochemical analysis demonstrated that the corresponding proteins are strongly expressed in the developing molar tooth germ, in particular the dental follicle and inner enamel epithelium. The descendants of these structures include the periodontal ligament, cementum, bone and epithelial rests of Malassez; tissues that are central to the ankylotic process. We therefore propose that ankylosis involves an increased inflammatory response associated with disruptions to the developmental remnants of the dental follicle and epithelial rests of Malassez.

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## INTRODUCTION

Dental ankylosis is defined as a fusion of cementum or dentine with alveolar bone.<sup>1</sup> Primary molar ankylosis can cause severe clinical consequences in the growing child, including:<sup>1–4</sup> (1) Tooth infraocclusion and vertical bone defect, (2) Tipping of adjacent teeth into the space of infraocclusion, causing loss of arch space, dental asymmetry, midline deviation,<sup>4</sup> and impaction of the ankylosed tooth and its successor, (3) Supra-eruption of opposing teeth, and (4) Deflected path of eruption of successors, with displacement in the form of tipping and ectopic eruption of successors.

Despite the abundance of clinical and epidemiological data, little is known about the molecular correlates of primary molar ankylosis. Genetic associations have been proposed, mostly based on epidemiological data from familial, ethnicity, and dental anomaly pattern studies.<sup>5–10</sup> However, despite compelling evidence for strong familial and ethnic associations, no candidate genes or molecular pathways have been identified.

A number of studies have tested hypotheses of molecular pathways of ankylosis. Prime among them is the dysregulation of proteins involved in hard tissue turnover. For example, descriptive studies of fixed tissues suggest altered expression of osteoprotegerin (OPG), receptor activator of nuclear factor kappa- $\beta$  (RANK), and RANK ligand (RANKL) in a rat model of ankylosis induced by thermal trauma using dry ice.<sup>11</sup> PDL space mineralization and dental ankylosis have been observed in animals with altered bone metabolism, for example in mutant mice with elevated Wnt signalling,<sup>12</sup> in osteopetrotic mutant rabbits with reduced osteoclast-mediated bone resorption,<sup>13</sup> and in mice injected with bisphosphonate.<sup>14</sup> A study of five human subjects with loss-of-function mutations in *ENPP1* associated with generalized arterial

calcification of infancy (GACI) found increased cementogenesis and reported histories of infraocclusion and ankylosis.<sup>15</sup> On the other hand, in a staining study, bone from ankylosed human primary molars demonstrated no difference in the expression of NADH-diaphorase, acid phosphatase, and alkaline phosphatase.<sup>16</sup>

The above studies suggest that animal models can provide useful insights into the functions of selected proteins and pathways, but are not representative of the ankylotic process in humans, which is unique in that it is not induced by trauma, is seemingly idiopathic and spontaneous, and has high prevalence (e.g. 22% in Finland<sup>17</sup> and 38% in Israel<sup>18</sup>) that cannot be explained by rare genetic mutations. So while these candidate gene and protein approaches can be informative, they are hampered by scale and scarcity of established candidates. Thus, it is timely to approach the problem using human transcriptome-wide analysis.

In this study, RNA sequencing (RNA-seq) was used to characterize and compare the transcriptome profiles of primary molars with and without infraocclusion. Following analysis, a small number of differentially expressed (DE) genes were examined for their protein distribution in developing tooth germs.

## RESULTS

### DE genes in bone tissue

After excluding genes with low counts (see the "Materials and methods" section), 18 529 genes were retained for further analysis, from which 432 genes (2.3%) were found to be differentially expressed between the two groups (false discovery rate (FDR)  $< 0.05$ ) (Supplementary Table 1). Of the 432 DE genes, all except two had  $\log_2$  fold change ( $\log_2FC$ ) of  $\leq -0.59$  or  $\geq 0.59$  (i.e. exhibiting 1.5-fold

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## Outcomes of autotransplanted teeth and prognostic factors: a 10-year retrospective study

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### Abstract

**Objectives** This retrospective study aimed to investigate the clinical outcome of tooth autotransplantation and related prognostic factors.

**Materials and methods** Eighty-two cases of transplanted teeth from March 2006 to December 2016 were retrospectively investigated by medical records and radiographs. The clinical outcomes of transplanted teeth, which included tooth survival, inflammatory root resorption (IRR), ankylosis, and marginal bone loss (MBL), and the related prognostic factors were assessed via survival analysis.

**Results** The cumulative survival rate of transplanted teeth was 74% at 10 years after autotransplantation. According to Cox proportional hazards regression analysis, the eruption state of the donor tooth, recipient position, and postoperative MBL were significantly related to tooth survival. The donor tooth position was significantly associated with IRR, the recipient position and the timing of orthodontic initiation with ankylosis, and the recipient position with MBL.

**Conclusions** Fully erupted donor teeth and a bounded recipient site were significantly associated with longer tooth survival. Periodontal healing and management to prevent postoperative MBL were as important for successful autotransplantation.

**Clinical relevance** Knowledge about the prognostic factors that are significantly associated with each particular clinical outcome may guide clinicians to achieve predictable and successful outcomes after tooth transplantation.

**Keywords** Autotransplantation · Survival analysis · Postoperative complication · Prognostic factor

### Introduction

Tooth autotransplantation is a treatment option that is used to restore an edentulous space by repositioning a patient's extracted tooth. It has several advantages over other treatment options such as fixed partial prostheses or dental implants. Successful autotransplantation can lead to normal periodontal healing, and proprioceptive function, which is the perception of natural chewing and natural biologic responses to external stimuli, can be preserved [1, 2]. In young patients, this procedure allows for the preservation of pulp vitality through revascularization and thus leads to complete root formation and osseous development, resulting in esthetic outcomes [3, 4].

Therefore, autotransplantation is often conducted in young patients with an impacted or traumatized tooth that requires reconstruction or repositioning [5, 6]. By incorporating orthodontic treatment into autotransplantation, the donor tooth can be strategically chosen as the most suitable candidate among several teeth to be extracted, and the general occlusion, including the extraction area, can be re-established. Over the last 3 to 4 decades, autotransplantation combined with orthodontics has exhibited great success and survival rates of transplanted teeth in children and adolescents [7, 8].

Recent studies have reported both short- [9, 10] and long-term [11, 12] high success rates of transplanted teeth, even with complete root formation. This results from the following precise diagnosis and application of strictly standardized treatment protocols. These protocols include minimizing damage to the periodontal ligament cells (PDLs) of the donor teeth using 3D images/models and careful surgical techniques [13], preventing infection by prior root canal treatment, activating PDLs of non-functioning teeth by exposure to prior orthodontic force [14], and applying semi-rigid splint or

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## Impacted and ankylosed teeth: Why, when, and how to intervene

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**F**or patients in the deciduous dentition, early treatment often means treatment of lateral crossbites. With lateral crossbites occurring in 10% to 15% of children, one might ask: why treat these children early? One common answer is because of the risk for unilateral masticatory function and growth restriction, which might

later lead to temporomandibular joint problems or facial asymmetry. However, little scientific evidence is available about future problems, especially on an individual basis.

The best age for crossbite treatment has been discussed. Some advocate maxillary expansion in the early mixed dentition. We can treat in the deciduous dentition by grinding, but the long-term effects are not well documented. In a study, the success rate of grinding to correct a crossbite was about 60%. However, in this report, spontaneous correction occurred in up to 45% of the untreated patients.<sup>1</sup> This means that treatment of lateral crossbite in the deciduous dentition might, in many cases, be unnecessary.

More information is needed about the long-term risks of untreated lateral crossbites, the effectiveness of different treatment methods, and whether to treat early or late. The questions of why, when, and how to intervene are important for all tooth eruption and occlusal problems in the developing dentition.

### Impacted teeth—mesiodens

Many times, a mesiodens is diagnosed when radiographs are taken at an early age because the permanent maxillary incisors have not erupted. These mesiodentes are, of course, surgically removed.

The question is, what risk do we run with mesiodentes that are not interfering with tooth eruption and development, and are left in place? The risks of enlarged follicles, cysts, and resorption of the permanent incisor roots should be considered.<sup>2</sup> However, in a recent study of 43 patients who were followed radiographically, no complications were found because of mesiodentes.<sup>3</sup> Therefore, in my opinion, early surgery is indicated only when the mesiodentes interfere with tooth eruption, occlusal development, or orthodontic tooth movement. In fact, cysts related to a mesiodens might be derived from the incisal canal (Fig 1). With time, the mesiodens seems to be stationary. During vertical growth and development in the anterior maxillary region, it might seem to move slightly apically (Fig 2).<sup>4</sup> However, true movement is a rare complication with a mesiodens (Fig 3). Movement is sometimes notable, but it normally has no serious consequences for the patient.

Many mesiodentes erupt spontaneously and are then extracted. Those not erupting, especially those in inverted positions, might be left and periodically radiographed for possible movement. Pathology such as resorption of permanent teeth, cysts, or follicular enlargement is extremely rare and does not warrant early removal in all young affected patients. Mesiodentes left alone might even resorb spontaneously with time.<sup>3</sup>

### Ankylosed deciduous molars

With a permanent successor in a normal position, the expected future development of an ankylosed deciduous molar should be a 6-month delayed shedding compared with normal shedding time.<sup>4,5</sup> Early treatment in the form of extraction of the ankylosed deciduous molar is thus unnecessary. Instead of phase 1 or phase 2 treatment, consider “phase 0”: don’t do anything.

With the permanent successor missing, spontaneous

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# Value of Computed Tomography (CT) in Imaging the Morbidity of Submerged Molars: A Case Report

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## ABSTRACT

Submerged primary molars can be difficult to manage due to the developing dentition. Rarely in some severe cases, may the surgical interventions be required while ensuring the vital structures are protected. Therefore these cases require sophisticated imaging techniques in order to locate the vital structures.

In this case report, a 17 year old girl who had a retained and submerged deciduous molar which caused impaction of the second premolar and tipping of the first molar was presented. In addition, value of computed tomography (CT) for locating the vital anatomic structures was discussed.

In our case, CT has been supplied effective information about localization of the vital structures and amount of bone volume during the diagnosis and treatment planning period in addition to the routine dental radiographies. [Eur J Dent 2007;1:246-250]

Key words: Submerged molars; Ankylosis; Impaction; Computed tomography.

## INTRODUCTION

The term "submerged" may be defined as teeth failing to erupt into a functional position and remaining under the occlusal plane. In the literature, "submerged" is often used synonymously with "ankylosed" and "infraocclusion". Although

the aetiology of submerged teeth is still unclear the following factors may affect a tooth to submerge.<sup>1-3</sup>

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- Ankylosis
- Periodontal membrane disorders
- Disturbed local metabolism
- Local mechanical trauma
- Local infection
- Chemical or thermal irritation
- Local failure of bone growth
- Abnormal pressure of the tongue
- Disturbance in normal hard tissue resorption and deposition
- Systemic diseases (congenital syphilis, endocrine disorders etc.)
- Heredity
- Abnormal germ position and direction
- Lack of space

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## Incidence and distribution of deciduous molar ankylosis, a longitudinal study

### ABSTRACT

**Aim** To study incidence and distribution of deciduous molar ankylosis.

**Materials and methods** Study design: longitudinal retrospective study. A total of 512 consecutive subjects (aged 5 to 15 years) were examined at the Orthodontics and Paediatric Dentistry Department of the Genoa University School of Dentistry; for each subject an orthopantomography x-ray was taken.

**Results** Thirty-four children were affected by deciduous molars ankylosis (6.6%). A statistically significant difference was revealed between the distributions: the lower deciduous molars were ankylosed more frequently than the upper ones ( $P<0.001$ ); the second deciduous molars were ankylosed more frequently than the first molars ( $P<0.001$ ). No statistical significance was found between sex and number of infraoccluded teeth ( $P=0.74$ ).

**Conclusion** This study found an incidence of deciduous molar ankylosis of about 6.6%; the lower deciduous molars and second deciduous molars were ankylosed more frequently ( $P<0.001$ ).

**Keywords:** Tooth ankylosis; Deciduous molars.

## Introduction

Ankylosis has been described by Mc Call e Wald [Falconi et al., 1987] and is a dental anomaly of unknown aetiology that causes bone bridges between root cementum and alveolar bone; for this reason, ankylosis hampers the normal development of the tooth involved and, consequently, prevents tooth eruption and growth of the

alveolar bone supporting it. Ankylosis seldomly affects the permanent dentition, while it has a frequency of 6-8% in deciduous molars, causing, in the most severe cases, local malocclusions, delayed and hook-shaped morphology of bicuspid roots, and a tendency to impaction of the tooth underneath the ankylosed molar (Fig. 1).

Diagnosis must necessarily be based on clinical and x-ray findings, because the histological examination, which is the proper diagnostic criterion, is not practicable in a longitudinal research.

Steigman [1973] had in view to check the earliest age at which ankylosis becomes clinically detectable, to determine the distribution frequency, and to investigate the most frequently affected arch. For this reason 1042 children aged 3 to 6 years were examined. Among the deciduous molars examined, 9.2% had ankylosis. At three years of age, it was found an incidence of about 8.4%. The incidence of ankylosis was greater in the lower dental arch ( $P<0.001$ ). The first deciduous molars were affected more often than the second molars ( $P<0.001$ ) both in the maxilla and in the mandible. In females the mandibular deciduous first molars and the maxillary deciduous second molars were affected more frequently ( $P<0.001$ ); in males the maxillary deciduous first molars and the mandibular deciduous second molars were affected more frequently ( $P<0.5$  and  $P<0.01$  respectively). The reason for the disparity in frequency between first and second deciduous molars and between upper and lower dental arches is unknown.

Other authors report a great variation in ankylosis frequency in deciduous dentition; unfortunately in many researches the age of children examined is not mentioned. Among these, we mention [all reported in Mueller et al., 1983] an European research [Dechaume and Cauhepe, 1948], in which 40 cases of ankylosis were found among 60.000 children (0.07%); an english study [Andlaw, 1974] on 1.539 children (5 to 11 years) which found a 3.2% incidence of ankylosis; in other studies, done in the U.S.A., ankylosis was found to have a 3.2% incidence in 2.105 children (8-12 years) [Brearley and McKibben, 1973]; 6.9% in 1.641 patients (2,5- 14,5 years) [Lamb and Reed, 1968]; 3.7% in 2,234 children from 6 to 12 years [Krakowiak, 1978].

Mueller [Mueller et al., 1983] planned a research in order to investigate the incidence of ankylosis by means of bite-wing x-rays in 1,895 United States patients (aged from 7 to 12 years), of a very heterogeneous ethnic

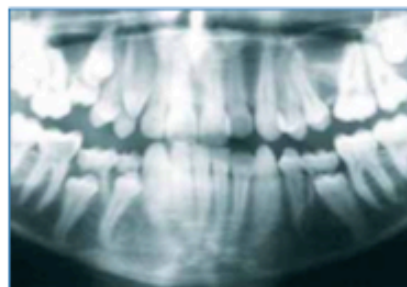


FIG. 1 - Hooked bicuspid roots under ankylosed primary molars.

# CASE SERIES:

## Atypical retention of infraoccluded primary molars with permanent successor teeth

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### Abstract:

**Background:** Infraocclusion of primary molar teeth is relatively common. The majority of infraoccluded primary molars with permanent successors exfoliate naturally. There are currently no evidence based guidelines for the treatment of infraoccluded primary molars with permanent successor teeth. **Case Series:** The three cases presented demonstrate atypical retention of infraoccluded primary molars, following a conservative approach. In case 1 taking a conservative approach over 5 years, the infraocclusion became gradually more severe. Tilting of the adjacent teeth and the centre-line shift caused by leaving the affected tooth in place during dental and alveolar development was significant. In Case 2 the severely infraoccluded 55 required surgical removal and exposure of the underlying permanent successor (15). Case 3 showed a maxillary premolar (14) and first permanent molar (16) tilted toward the partially erupted, ectopic, rotated 15. Surgical removal of the impacted maxillary primary molar was required. **Conclusion:** Although there is evidence available to support the conservative treatment of such cases, it does not always lead to a favourable outcome. Detrimental effects on the adjacent teeth and occlusion were observed and surgical intervention was required.

### Background

Infraocclusion (IO) may be defined in many ways, perhaps most simply by Andlaw and Rock [1996] as: "A tooth that has failed to maintain its position relative to the adjacent teeth in the developing dentition and is, therefore submerged below the occlusal level". The prevalence of IO has been variously reported as ranging between 1.3% [Ma, 1964] and 38.5% [Steigman et al., 1973] with most reports in the region of 1.3% to 8.9% and a peak prevalence in 8-9 year olds [Kuroi, 1981]. IO is more common in Caucasian subjects with no sex predilection noted [Krakowiak, 1978]. Mandibular first primary molars are the teeth most frequently affected [Brearley and McKibben, 1973], and are more commonly than permanent molars [Biederman, 1956] and mandibular molars more than maxillary molars [Messer and Cline, 1980; Kuroi, 1981].

Diagnosis is usually by clinical presentation with severity classified as mild, moderate or severe, according to the position of the occlusal surface of the infraoccluded tooth

relative to the adjacent teeth [Brearley and McKibben, 1973]. The IO may become progressively worse with age [Darling and Levers, 1973; Krakowiak, 1978] and continuing adjacent vertical alveolar growth.

The mechanism for IO is not fully understood but trauma to the primary dentition may cause disturbance of eruption, due to abnormal tissue changes overlying the tooth germ [Andreasen, 1994]. Deficient eruptive force [Dixon, 1963], disturbed metabolism of the periodontal ligament [Biederman, 1953], local inflammation, and disturbance in interaction between normal resorption and hard tissue repair [Kronfield, 1953], have all been postulated as possible causes of infraocclusion. Defects in the periodontal membrane [Biederman, 1962] and localized infection [Adamson, 1952] have also been suggested [Kuroi and Thilander, 1984]. There are three main, generally accepted factors in the aetiology of IO.

**Ankylosis:** Dental ankylosis is thought to be the major aetiological mechanism of IO, [Darling and Levers, 1973; Kuroi and Magnusson, 1984], although ankylosis may be a secondary, rather than an initiating factor in the process. It has been postulated that ankylosis can develop during the intermittent processes of root resorption and bone deposition, which occur in the physiological resorption of the primary tooth root [Kuroi and Magnusson, 1984]. Ankylosis occurs if there is a break in the continuity of the periodontal membrane and direct contact of cementum or dentine and bone occurs [Krakowiak, 1978]. There is an increased degree of osteoblastic and osteoclastic activity with ankylosed teeth, as compared to normal teeth; and in favourable circumstances, the attachment of the affected tooth to the underlying tissues may be resolved and the tooth shed normally [Dixon, 1963; Thornton and Zimmerman, 1964].

**Genetic basis:** It has been proposed that IO is an hereditary condition, inherited on a multi-factorial basis, either with polygenic inheritance or controlled by an environmentally-sensitive single gene [Kuroi, 1981]. A familial tendency has been noted, with an increased incidence amongst siblings of 18.1% [Kuroi, 1981] and 44% [Ma, 1964] also suggesting a genetic component to the aetiology. IO of primary molars also shows significant reciprocal associations with genetically related anomalies: ectopic eruption of first permanent

**Key words:** Infraocclusion, Permanent successor, Primary Molar

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