The unresolved problem of the third molar

Would people be better off without it?

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ABSTRACT

Background. Third molars are teeth that have little functional value and a relatively high rate of associated pain and disease. Their value as part of the dentition of modern people is dubious.

Types of Studies Reviewed. The authors review the evolution, development, morbidity and treatment of third molars. They assess the value of third molars in the 21st century and describe the risks these teeth pose when they develop in the dentition.

Conclusions. There is a mandate for the dental profession to improve health outcomes and quality of life. The prevention of third molar–related morbidity should be included in dental research efforts. The authors suggest that novel preventive methodologies be developed to alleviate the problems third molars pose. One potential methodology suggested is intentional therapeutic agenesis of this tooth.

Clinical Implications. Prevention of third molar development early in life, even before tooth bud initiation, could dramatically improve health care outcomes for millions of people.

Third molars are a source of pain for many people. These teeth have been the cause of dental disease in people who have not had them extracted and the cause of serious trauma for many people who have had them extracted. Although the dental profession has witnessed a dramatic reduction in dental disease and tooth loss over the last century, the problems associated with third molars persist. The evolution of third molars in the longer jaws of human's ancestors reveals the benefit these teeth may have added to the dentition millions of years ago. In modern humans, however, third molars add little to the chewing efficiency of the dentition. As jaw sizes have shortened over the ages, so too has the space that is necessary for third molars' inclusion in the dentition. Many people who retain their third molars into adulthood find that one or more are impacted or difficult to clean.

During the last century, defining a useful purpose for third molars has become more difficult.

Whether there is a need for these teeth in the dentition of 21st century people is a question worth asking. In this article, we examine the function and importance of third molars. We trace their evolution, describe their growth and development and evaluate their usefulness in 21st century people in light of oral health changes that have occurred. We also pose thoughtful, serious questions with respect to the need for third molars and consider whether the risk/benefit ratio of their presence warrants their development and inclusion in the dentition. Finally, we challenge the dental research community to develop novel, preventive, therapeutic approaches to alleviate the pain and suffering these teeth cause.

THE EVOLUTION OF THIRD MOLARS

Evolution is a complicated subject with many differing theories that are being reexamined in light of emerging genetic discoveries.[1] One common and widely accepted explanation of tooth evolution contends that molars evolved when humanity's ancestors roamed the earth on four legs more than 100 million years ago.[2] These animals confronted their environment with their heads and had limited use of their front appendages for any survival skills other than running. The position of the head on the spinal column was rotated backward, placing their jaws and teeth forward in prime position for use. Teeth were a vital survival tool used in catching, killing and eating uncooked prey; confronting and

fighting enemies; and gathering, manipulating and chewing food. Evolution likely favored the development of large third molars and the added chewing surfaces they provided when jaws were large and there was a survival advantage to possessing teeth.

The dependency on teeth for survival began to decrease several million years ago when hominids assumed an upright posture.[3] Front appendages evolved to form arms and hands, which assisted in essential survival skills such as hunting, fighting and gathering food—tasks previously performed nearly exclusively by the teeth. Higher neural function evolved over the last million years or so, leading to the creation of powerful offensive and defensive hand-held weapons and tools, which further reduced the dependency on teeth for survival. The discovery of fire and the creation of cooking utensils allowed early humans to boil and soften their food, ensuring humanity's survival even if people possessed no teeth at all. As a result of these dramatic biological and cultural evolutionary changes, people have experienced a decreased dependency on all tooth types, particularly third molars, over the ages.

Third molars are the only teeth that develop entirely after birth.

Speculation and work done by dentists, paleontologists and other investigators have helped explain the evolutionary changes observed in the size, shape and position of teeth in people from early hominids to modern humans.[4,5] In modern people, third molars have the highest frequency of polymorphism, malposition in the dental arches, impaction and agenesis.[6,7] Approximately 65 percent of the human population has at least one impacted third molar at 20 years of age,[8] and third molars that do erupt frequently are malposed in the arches and consequently are difficult to clean. These aberrations in third molar patterning may be related to the shortening of the jaws that occurred in people over time.[9,10] However, the reasons these aberrations occur and the mechanisms that control them remain elusive.[11-13]

THE DEVELOPMENT OF THIRD MOLARS

A biological review of the events that result in the development of third molars sheds light on why these teeth may develop frequently with morphological malformation, malposition and possibly even agenesis. Third molars are the only teeth that develop entirely after birth. All other teeth begin development in utero or, as in the case of permanent second molars, are entering into the tooth bud stage of development near birth.[14] The initiation of the development of third molars does not begin until ectodermal dental lamina, migrating distally in the growing child's mouth, spatially relates to and interacts with jaw mesenchyma, which is derived from the embryonic cranial neural crest. In the case of third molars, the interaction of these two tissues is initiated well after birth after significant jaw growth at around 5 years of age.[15] If these two tissues never interact, no tooth will form. Since no subsequent similar interaction occurs between these two distinct tissue types after third molar tooth bud initiation, no other teeth develop at a later age. Development for all mammalian teeth is very similar after tooth bud initiation.[16]

Initiation of third molars occurs macroscopically at or near the surface of the developing jaw bone.[17] During the five years from birth to the initiation of third molars, genetic factors and environmental factors influence jaw growth and dental lamina migration, which ultimately may affect the timing of the interaction and final positioning of the two tissues necessary for the initiation of tooth bud development. For normal tooth patterning to occur in regard to size, shape and position, the two tissues must be in the right place at the right time.[18,19] Alteration in the pattern of jaw growth, as well as changes in the migration of dental lamina, occur due to evolutionary forces and environmental factors such as trauma and disease. Environmental factors and teratogens have been shown to affect tooth development[20-24] with devastating effects on tooth size, shape and position. It is not surprising, therefore, that aberrations in normal third molar patterning frequently occur.

THIRD MOLAR MORBIDITY

Prehistoric people likely did not have the infections we associated today with impacted and partially impacted third molars.[25] Although caries and periodontal disease were prevalent,[26] evidence suggests that dental pathology was relatively low.[27] The disintegration of the dentition in prehistoric people appears to have been primarily the result of extreme occlusal wear and its accompanying sequelae.[28] Third molars, therefore, may have played a useful role in decreasing the rate of occlusal wear by increasing the surface area

available for chewing.

Toward the end of the 17th century, people experienced a dramatic increase in the prevalence of dental disease, most likely a result of a dramatic shift in lifestyles and diets.[25,29,30] From that time until the advent of modern dentistry at the beginning of the 20th century, there was a dramatic acceleration in the rate of dental disease associated not only with third molars but also with every other tooth. Today, despite advances in preventive dentistry, the location of third molars in the dental arches often makes them difficult to care for, and their frequent impaction exposes patients to degenerative conditions infrequently associated with any other tooth type.

It is difficult to assess the actual morbidity associated with the presence of third molars in modern people due to the lack of reliable data.[31] Most studies have been short-term, cross-sectional analyses of clinical encounters that rely heavily on radiographic evidence of disease and are supported with little or no histopathologic evaluation of tissue. Further complicating the analysis of morbidity data is the difficulty of assessing lifelong prevalence for disease when many asymptomatic, disease-free, impacted third molars are extracted prophylactically early in life.[31] Hicks[32] and others[33,34] argue against routine removal of apparently disease-free, asymptomatic, impacted third molars, in part, because the decision to do so is based on the inherently flawed morbidity data. Others show that there are increased risks associated with extracting third molars in later life such as periodontal defects on the distal surface of the second molars,[35,36] complications from surgery[37] and nerve injury.[38] A recent retrospective histopathologic study of more than 2,600 pericoronal lesions of extracted unerupted teeth showed a relationship between pathologically significant disease and age.[39] The authors suggest that the potential for the development of significant, even life-threatening, disease should be considered in the decision-making process when managing the care of patients with impacted teeth. Meanwhile, the controversy over when to extract and how to best manage third molars continues.

CLINICAL TREATMENT OF THIRD MOLARS IN MODERN DENTISTRY

Some patients gain functional benefit from the restoration of third molars when, for example, a third molar is used as an abutment for a fixed or removable prosthesis when other more functional molars have been lost due to disease or trauma. Some orthodontic patients gain functional benefit from third molars if their orthodontic treatment involves the extraction of permanent first or second molars. The clinical value of third molars in some selected clinical situations, therefore, cannot and should not be overlooked.

While some patients do gain functional benefit from the dental treatment of third molars, many other patients have them extracted. Third molar extraction is the most commonly performed procedure in the practice of oral and maxillofacial surgery.[40] The pain and morbidity associated with third molar extraction is well-known, and surgical removal of impacted third molars even has been used extensively as a model in the evaluation of analgesics, steroids, antibiotics, general anesthetics and sedatives over the years.[41]

Although no exact figure exists for the number of third molars extracted annually, a conservative estimate in the millions worldwide is reasonable when one considers that nearly 1,500 surgical extractions were performed at one hospital during one year.[42] In another study of four metropolitan hospitals, more than 2,500 impacted mandibular third molars were extracted in one year.[43] These statistics excluded the third molar extractions routinely performed at private dental practices.

When third molar extractions are performed, complications can occur during and after the surgical procedure. Extraction of partially formed or fully formed third molars is an invasive surgical procedure that is traumatic to the dentoalveolar tissues and the patient's psychological well-being. Pain, bleeding, swelling, trismus, infection, alveolar osteitis, nerve injury and adjacent tooth damage are some commonly encountered complications. Sinus involvement, displacement of fractured roots, tuberosity fracture and mandibular fracture also occur but less frequently.[8] Even death during third molar extraction is documented in the literature.[44] In one article, the overall incidence of operative complications during surgery was estimated to be approximately 18 percent and the incidence of complications after surgery approximately 20 percent.[8]

The advisability of the removal of asymptomatic impacted third molars by early prophylactic surgical extraction has been debated in dentistry for many years.[32] Despite a 1979 conference on third molar removal sponsored by the National

Institutes of Health,[45] no unanimity of agreement has been reached within the profession, and decisions on whether to extract third molars largely are based on practitioners' experiences and bias.[46,47] The conference did conclude that impacted third molars represent an abnormal state. While proponents of the routine surgical extraction of third molars believe that early extraction is preferable to the potential for pathological degeneration and disease of these teeth later in life, clinicians who do not support routine prophylactic extraction feel that there is a lower risk of pathological degeneration and disease compared with the risks of surgery.

THE FUTURE OF THIRD MOLARS AND THE POSSIBILITY FOR CHANGE

The mandate for dentistry in the 21st century calls for continued efforts directed toward eliminating dental disease and enhancing the overall health and well-being of patients by translating scientific discovery into clinical practice.[48] There is opportunity to extend the mandate to the paradoxical third molar and the dilemma it creates for patients.

One theoretical clinical possibility is intentional therapeutic agenesis of third molars before initiation when no third molar tooth tissues exist. Gordon and Laskin[49] and Selinger and colleagues[50] recognized that some teeth, such as third molars, pose problems for people, and they achieved limited success at inhibiting odontogenesis using cryogenetics and sclerosing agents in dogs. Their research focused on stopping succedaneous premolar tooth development after initiation when considerable tooth tissues already had formed. Succedaneous premolars develop in a slightly different manner and position than nonsuccedaneous human third molars.

Since the initiation of third molars occurs at or near the surface of the jawbone just millimeters below the oral mucosa, their location is relatively accessible in children. In lower mammals that have third molar developmental stages comparable with those of humans, early studies have shown that selective third molar agenesis can be accomplished with several minimally invasive techniques that use electrosurgery and laser energy (Anthony R. Silvestri, D.M.D., unpublished data, January 2002). Even small amounts and concentrations of locally delivered teratogens such as alcohol have stopped third molar development in rats (Anthony R. Silvestri, D.M.D., unpublished data, January 2002). The lack of expression of certain growth factors,[51,52] the presence of vitamin-derived retinoic acid derivatives[53,54] and the presence of commonly ingested food additives like citral[21] have been shown in the basic science literature to have dramatic effects on tooth bud initiation and early tooth development. It may be possible to selectively stop the development of third molars by specifically targeting either epithelial dental lamina migration, the initiation of tooth bud development or the earliest initial stages of tooth development with extremely small quantities of a locally delivered therapeutic agent. Because no third molar exists from birth until nearly five years of age, a window of opportunity exists for the elimination of third molars before they form, and many people could benefit from the successful attainment of this long-term goal.

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DISCUSSION

Clinicians and their patients are familiar with the problems and distress third molars can cause. As a result, they frequently are confronted with a dilemma when deciding what to do if this tooth develops. If the decision is to extract third molars early before disease potentially may occur, patients face the certain psychological and physical trauma of surgery performed at a young age. If the decision is not to extract third molars early, patients face the uncertainty of disease and the likelihood that if extraction becomes necessary it likely will be more difficult, with the increased possibility of serious postsurgical morbidity. Neither management option offers a patient the assurance of a desirable outcome.

In addition, third molar extraction comes at great financial expense. In the United States alone, the amount spent each year for the extraction of third molars is estimated to be more than $2 billion,[31] excluding the costs of examinations, radiographs, medication, anesthesia or hospital or surgical center charges. The time lost from work, estimated to range from one to six days with an average of one day's lost wages, also needs to be

included.[55] Near the end of the 20th century, one major U.S. health insurance plan reported that annual cumulative costs for third molar surgery exceeded those of every other kind of major surgery.[56] The financial resources that insurance companies expend on the extraction of third molars rival those spent for any other single surgical procedure, medical or dental. Expenditures for third molar extractions are enormous, and this is a major, growing concern for administrators of public and private sources of health care funding.[57]

Emerging information relating to tooth development, gene expression during growth and development and the human genome project has given clinical health care professionals hope that scientific discoveries will lead to novel therapeutic modalities that will foster disease prevention and improve patients' quality of life.[48] Significant opportunities exist for basic scientific knowledge to be applied to solving clinical problems in the area of developing human beings.[58-61] The potential elimination of the problems caused by third molars through the prevention of their development is an area for investigation that is worthy of consideration. In the last 30 years, there has been intense interest in the biomolecular events involved in tooth development. The result has been a heightened research interest in growing new teeth.[62] Perhaps it is time to develop techniques to stop their development as well.

CONCLUSION

Third molars may have served a useful purpose in prehistoric humans when jaw sizes permitted space for normal development and position in the arches and when teeth may have played a more vital role in survival. During the last century, however, defining a useful purpose for third molars has become more difficult, especially when one considers that people experience pain and disease when third molars are not extracted, and many other people experience pain and morbidity when they are extracted.

As dental research develops new techniques to reduce and possibly eliminate the loss of teeth resulting from caries and periodontal disease, the usefulness for third molars in the dentition will decrease further. At the same time, third molar–related morbidity likely will continue to affect people, and the costs to manage it likely will continue to consume large portions of the health care dollar.

Dentistry needs to ask questions about third molars. Are the risks of possessing third molars offset by the benefit that results from their inclusion in the dentition? Would people be better off if third molars were intentionally prevented from developing? If the mandate for the dental profession is to improve health outcomes and quality of life, it is time for dental research to focus attention on solutions to the problems caused by the paradoxical third molar in 21st century humans. ■

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