

Normal Aging of Teeth

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The rate of edentulism (being toothless) is declining in older adults. Thanks to more effective community-based prevention programs, reliable treatment methods, and improved dental technology, people are retaining more of their natural teeth. Since it has been only recently that people have lived as long and retained so much of their teeth, research done in the area of normal and abnormal aging of the teeth is limited. This article reviews some of the current knowledge regarding normal aging of the different structures of teeth and clinical manifestations of advancing age. More specifically, age-related changes in tooth enamel, dentin, pulp, and cementum are reviewed.

Key words: aging, dental, teeth, older, adults

Introduction

The expression “growing long in the tooth” has been ubiquitously used to describe the process of getting old. However, whether people literally grow “long in the tooth” with age is debatable. Changes occur naturally in the mouth with altered function and time. Normal age-related changes to the tissues in the mouth differ from changes that occur from trauma, infectious and noninfectious disease, and unnatural wear. Unfortunately, the line demarcating normal from abnormal change blurs with advancing age and, at times, can make identification of pathologic change more difficult in older adults.

Throughout life, the teeth and other surrounding tissues in the mouth experience mechanical and chemical wear from daily mastication. The texture types and the pH levels of foods and beverages affect rate of tooth wear.^{1,2} In addition, other factors such as culture, diet, occupation, and geographic location influence patterns of changes to teeth.³ The aggregate accumulation of varying experiences throughout life can substantially affect the appearance, composition, resiliency, and strength of teeth and surrounding tissues. Therefore, the designation of what constitutes normal change in teeth and the dentition of older adults encompasses a broad spectrum.

Dentition

On average, adult teeth begin to erupt at the age of six and the last teeth excluding third molars finish eruption at around 12 years. Thereafter, most people will end up having 28 functioning adult teeth. Enamel, cementum, dentin, and the pulp make up the four major tissues of teeth (Figure 1). With the eruption of teeth the periodontium, consisting of surrounding alveolar bone, supporting ligaments, cementum, and gingival tissues, form and provide support for the teeth (Figure 2). Along with the periodontium, the root and pulpal tissues continue to form. Generally, 6 months following a tooth’s initial eruption, the root apices close, signifying complete maturation of the tooth. The completely formed teeth and the periodontium should remain intact in the mouth and fully functional without disease for a lifetime.

One of the clearest and easiest measures to determine history of dental disease is tooth loss. Outside of prophylactic extractions, tooth loss serves as a proxy for pathologic processes such as dental infection, caries, periodontal disease, dental pain, or trauma.^{4,5} However, 40% of over 1,300 teenagers interviewed in Quebec believe that tooth loss is a normal consequence of aging.⁶ The high prevalence of missing teeth in the community may perpetuate this type of false

assumption. According to the Canadian Community Health Survey (CCHS) conducted in 1990, nearly one out of every two Canadian age 65 and older was completely edentulous.⁷

Fortunately, current trends show large declines in rates of complete tooth loss in Canada and other parts of the world. A more recent survey conducted by CCHS indicates a substantial drop in the rate of edentulism; 30% of Canadian adults ages 65 and older were completely edentulous compared to 48% reported in 1990 as stated above.⁷ Today, people possess more of their natural teeth and retain them longer into their lives. In large part, this phenomenon can be attributed to what many consider one of the greatest public health initiatives in recent history: community fluoridation.

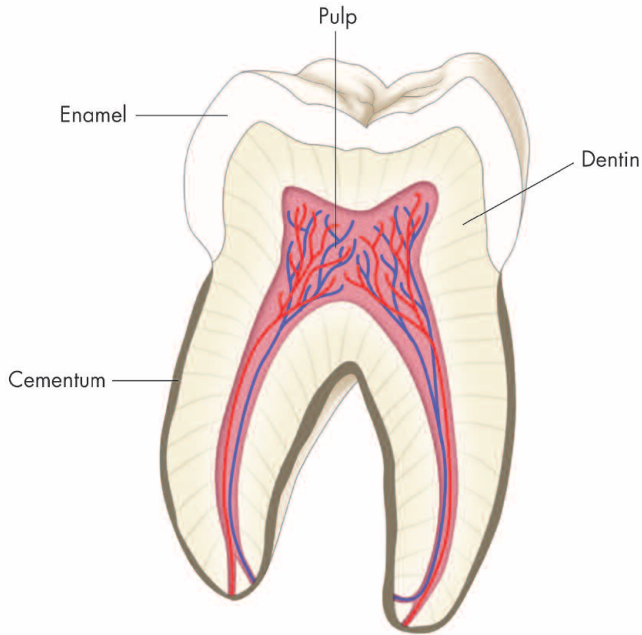
Since 1945, the year the city of Brantford, Ontario first introduced water fluoridation to Canada, the proportion of the total Canadian population with access to fluoridated water has grown to 45.1%.⁸ Not only have the rates of edentulism declined, but dental decay in communities with fluoridated water has also declined.^{9,10}

With the Baby Boomer generation fast approaching their senior years and having lived through the era of fluoride, we can expect many of them to have teeth intact. On the other hand, because of the foreseeable rapid expansion of the older adult population, we can also expect the total absolute number of people with partial and complete edentulism to increase in the next several decades.^{11,12} Consequently, the absolute number of older adults needing dentures, implants, or other prosthetics will increase. Therefore, health care providers and policymakers should be aware of the impending increase for the need of dental services and the subsequent demand for treatment and maintenance from older adults both with and without teeth.

Teeth in Normal Aging

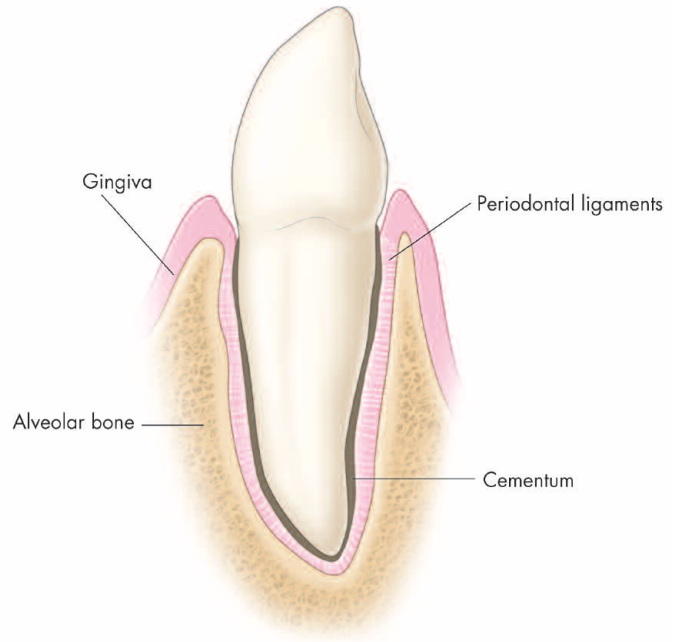
Teeth in healthy aging exhibit change in both visual appearance and molecular makeup. Even soon after eruption, changes are readily noticeable. For

Figure 1: Major Tissues of the Tooth



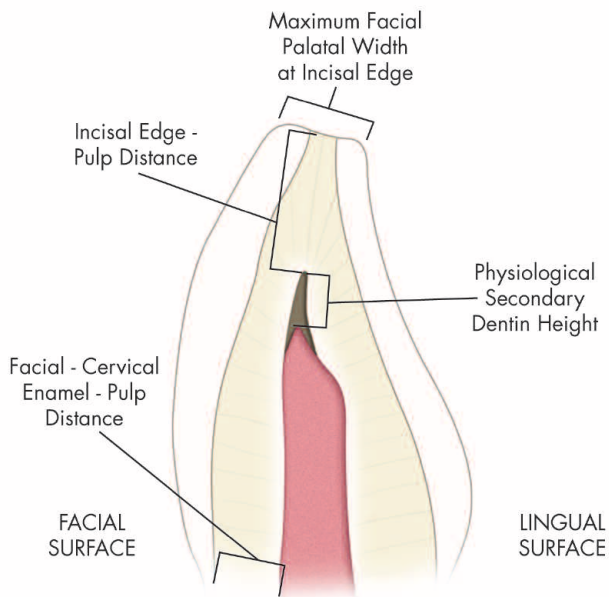
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Figure 2: Development of Periodontium Following Tooth Eruption



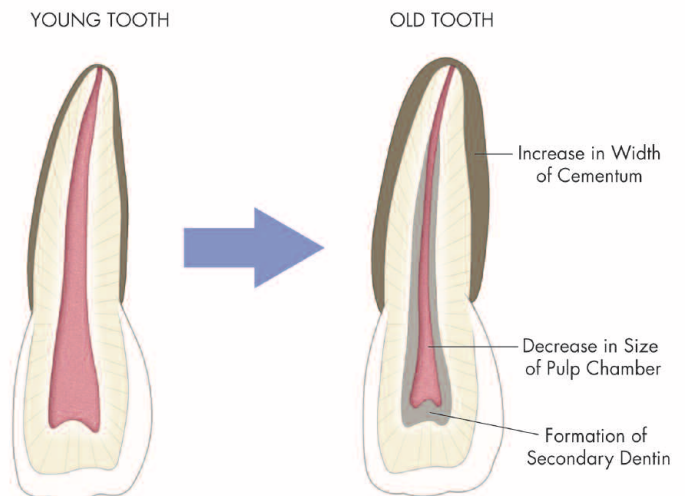
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Figure 3: Increases with Age of Physiologic Secondary Dentin Height and Incisal Edge Enamel-pulp



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Figure 4: Changes to Dentin with Aging



The secondary dentin grows inwardly into the pulp chamber decreasing the chamber's size.

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instance, over 90% of newly erupted anterior permanent teeth have three small protuberances along their incisal edges called mamelons;¹³ these mamelons usually wear off completely only a few months after the incisors come into functional position. Teeth continue to wear down as a normal consequence of use over the lifespan.

Although tooth enamel is the hardest tissue with the highest percent of mineral content in the body, the cusps and incisal edges flatten, and structural details on the enamel diminish with age and function. Yet, the outer enamel surface exhibits increased hardening with age. By age 55 and over, both the hardness and the elastic modulus of old enamel can increase by over 12%.¹⁴ A possible explanation is the continuous deposition of fluoride on enamel's surface resulting in the increase in fluoride concentration of enamel.¹⁵ The result of the increase in hardness and elastic modulus likely increases the brittleness of teeth and decreases permeability. Consequently, cracks along the enamel surface occur in aging teeth. Other wear patterns include the site-specific thickness of enamel. A study done with electron microscopy reveals that enamel thickness changes depending on location with age.¹⁶ Figure 3 illustrates the thinning of enamel at the base of the tooth adjacent to the gingiva (cement-enamel junction) and the thickening at the incisal edge (maximum facial-palatal width) due to wear with advancing age. These phenomena results in an overall decrease in

the height of the tooth's crown.

Dentin undergoes two important structural changes as it ages: the formation of secondary dentin and the sclerosing or obturation of the dentinal tubules.^{17,18} Secondary dentin forms after the complete formation of the tooth and consists of two types: physiologic secondary dentin, which forms with normal stimulus, and reparative secondary dentin, which forms with traumatic or abnormal stimulus. The secondary dentin grows inwardly into the pulp chamber decreasing the chamber's size (Figure 4). Dentinal tubules, which make up the structure of dentin, extend from the outer surface adjoining enamel and cementum to the pulp chamber. The tubules allow external stimuli such as hot, cold, and sweet to transmit into the pulp. As the dentin ages, the fluid that resides in tubules become obturated by peritubular dentin. By age 80, almost all dentinal tubules are fully occluded.¹⁹ The effect of both the increase in secondary dentin and obturation of dentinal tubules results in a decrease in sensation to hot, cold, and pain.

Commonly, older adults will not complain of tooth pain even with obvious injury or infection to the tooth. Figure 5 shows an individual with abnormally shortened teeth from habitual clenching and grinding resulting in excessive wear. Interestingly, the individual pictured did not complain of pain. A condition like this in a young individual would most likely exhibit severe thermal sensitivity and extreme pain from pulpal exposure. However, in an older adult, the lack of discomfort may be caused by age-related changes in the dentin, which provide insulation or protection to the pulp. Although perceived pain is dulled, the risk for dental trauma or disease increases.²⁰

When problems such as dental caries occur, the decrease in sensation reduces the likelihood for older individuals to perceive the problem and, subsequently, seek early dental care. When older adults do eventually seek care for a toothache, it is likely that either the disease has progressed to an advanced stage or the

Figure 6: Gingival Recession Due to Attachment Loss of Gingiva



Source: Original photo by Gregory An with consent of patient.

source of pain actually originates outside the tooth.²¹

Although the dentinal thickness may aid in pulpal protection, the pulp itself decreases in its reparative capabilities with age.²² The pulpal blood flow declines in older adults due to a decrease in the number of blood vessels, and an increase in calcified tissues in tooth pulp.^{23,24} In addition, magnetic resonance imaging (MRI) findings suggest a decline in pulp signal intensity.²⁵ Comparison of teeth within the same mouth showed a decline in pulp signal intensity in relation to age of individual teeth measured by time of eruption. Pulp stones, benign masses of mineralization within the pulp chamber, occur in approximately 6–7% of normal pulp in older adults.²⁶ The results of these physiologic changes along with dentinal thickness decrease pulpal resiliency and its ability to sense insult.

Cementum connects the tooth to

Figure 5: Abnormally Shortened Teeth Due To Excessive Wear



Source: Original photo by Gregory An with consent of patient.

Figure 7: Root Caries in the Dentin



Source: Original photo by Gregory An with consent of patient.

Key Points

Tooth loss is not a normal process of aging. It indicates a history of disease or trauma.

A larger percentage of people are keeping their natural teeth longer into their lives.

Concomitantly, the absolute number of people with partial or complete loss of teeth will increase. Therefore, the access to dental services must grow to meet the inevitable increase in demand.

Teeth's ability to sense external stimulus decreases with age. Therefore, when there are dental problems, older people are less likely to perceive them until the problem is advanced.

The "long in the tooth" appearance can occur with gingival recession or attachment loss. However, shortening of teeth can occur with excessive wear of the biting surfaces.

Older adults experience an increase in rates of dental decay, especially along exposed root surfaces

the periodontium along the root surface. As cementum ages it gradually thickens near the apex of the root (Figure 4). The thickness of cementum triples from ages 10 to 75 years.²⁷ Conversely, cementum thins out and eventually becomes lost in areas that are exposed due to gingival recession. Recession in older adults occurs more frequently because of a lifetime of abrasive forces and/or periodontal disease. Figure 6 shows an individual with obvious gingival recession due to attachment loss of gingiva. The teeth appear to look longer, hence, the expression "long in the tooth." Eighty-eight percent of people age 65 years and older exhibit some recession.²⁸ In the areas of recession, the cementum abrades from mechanical and chemical wear, thereafter exposing dentin. If the wear occurs faster than the formation of reparative dentin, the tooth will likely experience sensitivity. However, this sensitivity occurs less frequently in

older adults due to the thickening secondary dentin and the shrinking pulp.

Root Caries: an Epidemic of Aging Teeth

Root caries, a pathologic process, occur with greater frequency in older adults than in any other age groups.²⁹ Figure 7 shows an individual who had gingival recession, lost cementum due to abrasion, and subsequently formed root caries in the dentin. Xerostomia, a common symptom in older adults, along with cementum loss, gingival recession, poor oral hygiene, high plaque, and periodontal disease increase risk for root caries.

A thorough discussion of the etiology, diagnosis, and treatment of root caries of teeth is beyond the scope of this article. However, physicians and their staff can play an important role in detecting root caries and referring to dental providers when necessary for appropriate treatment. Along with an oral cancer screening, a simple visual exam of teeth and

gingiva can be effective in detecting root caries. Figure 7 illustrates an example of appearance; usually dark and concave in appearance along the exposed root. Patients commonly will not complain of any symptoms. However, if left untreated, root caries can progress into pulpal infection resulting in local infection of surrounding bone and gingival tissue. If detected early, simple treatment options are available to preserve the health of the teeth.

Conclusion

Older teeth have unique characteristics in appearance. The thickening and sclerosing of dentin creates a yellowish less translucent appearance of teeth. In addition, the increasing amount of crack lines that appear in enamel become more apparent as they stain with age. Gingival recession can exaggerate the appearance of a "long tooth." However, the wear along the biting surfaces of teeth can counteract the "long tooth" appearance. The chemical and mechanical wear along the cementum and roots creates grooves along the gingival line that can readily stain and form root caries. Teeth can also worsen in crowding, especially in the lower anterior incisors.^{30,31}

The properties responsible for sensation in the teeth change with age. Generally, older adults feel less pain and thermal stimulus to their teeth. Teeth become less likely to recover from insult such as dental restorative work, trauma, and infection. Unfortunately, older adults are less likely to sense problems until they become much more serious.

A growing number of older adults are keeping their teeth longer. The future holds a growing need for dental services to keep people's mouths healthy and functional. The mounting body of scientific evidence suggests the importance of oral health in contributing to general health. Therefore, oral health and maintaining healthy teeth should be a priority throughout life.



No competing financial interests declared.

Clinical Pearl

Tooth loss with age is preventable and, most often, needless. Although teeth change in structure and appearance as it ages, it should remain intact and functional for a lifetime with proper care. Older adults, especially, should see their dentist at least annually for a check-up whether they perceive a problem or not.

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