Wax: An Overview

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Citation

N Baisakhiya, S Golher, Prashant. *Wax: An Overview*. The Internet Journal of Otorhinolaryngology. 2008 Volume 9 Number 1.

Abstract

Ear wax is the common condition which every otolaryngologist encounters in there clinical practice. Wax production represents the normal biophysiology, but there are certain factors which affect this process. These factors are age, socioeconomics status, canal diameter, condition of tympanic membrane, factors affecting the lateral migration of cerumen and microbiology. In this review article we discuss the conditions which are affecting the production and migration of cerumen and its impaction and also the agents which are commonly used as a ceruminolytic.

INTRODUCTION

Manifestations attributed to the accumulation of ear wax (cerumen) are one of the most common reasons for people to present to the otologist with ear trouble. Conversely cerumen impaction represents the most common otological problem encountered by otologists. The presence of ear wax in the external ear canal is a normal and healthy phenomenon. It lubricates the ear canal, acts as a water repellent and also serves as a trap for dust, hairs and insects. It wouldn't be superfluous to observe that cerumen has got multiple implications and significance. Cerumen type also provides a decisive challenge to conventional racial categories. The biologist Stanley Garn recognized the peculiar racial significance of cerumen, “ear wax polymorphism”. Garn has rightly observed “ear wax separates east from west; and unites blacks and whites” [1] . The physiology, clinical significance and management implications of excessive and impacted cerumen remains poorly characterized. There have been no well designed, large, placebo controlled double blind studies comparing treatment modalities and accordingly the evidence surrounding the management of impacted cerumen is inconsistent, allowing few conclusions. The causes and management of impacted cerumen requires further investigation. Currently in patients with impacted cerumen, the lack of evidence makes this impossible [2] .

DISCUSSION

It is a matter of considerable interest that ear wax formation which is very much a part and parcel of normal physiological vagaries and an entity which under normal circumstances is expected to be extruded from the ear canal by the ‘conveyor belt phenomenon' of lateral migration which is a hall mark of the external auditory canal occasionally tends to linger in the canal and what more, occlude and even impact the canal leading to a plethora of symptomatology and manifestation much to the consternation of the patients and compels the otolaryngologist to devote much of his time in dealing with and occasionally wondering at the vagaries of this seemingly innocuous entity. It will be thus of some utility to ponder upon the plausible factors that might play a role in the excessive formation of ear wax and also in the impaction that it causes in the external auditory canal. The scoring pattern was given by MM Carr et al [3]. Score 1(no cerumen in the ear canal), score 2(minimal cerumen in the ear canal), score 3(partial occlusion of the ear canal walls) and score 4(complete occlusion of the ear canal with or without impaction).

AGE AND DIAMETER OF EXTERNAL AUDITORY CANALS

The possible predisposition of age towards production and impaction of ear wax was observed and maximum ear wax scores were seen in pediatric age groups and young population in the second decade of life; comparatively lower scores were observed in the middle age groups, MM Carr et al. [3] High cerumen scores were seen in elderly age groups also. It was also observed that impaction is more common in pediatric age groups and as age advances the tendency of wax is generally not to cause impaction through in elderly population the tendency to impaction again predominates,

thus showing a bimodal representation of impaction in the extreme age groups. This may be due to the increased production of cerumen in the pediatric age group as cerumen being a mixture of ceruminous and sebaceous gland secretion and that sebum secretion begins to increase at about the age of 7 and continues to do so well into the teens as observed by Stewart ME et al [4] and thereafter shows a gradual decline as observed by Jacobsen E et al [5] . Also the increased incidence of impaction in extreme age groups may be owing to the narrowing of the external auditory canals. Younger age groups in the first two decades were found to have comparatively smaller external auditory canal diameters as compared to adults though it has also been observed that a considerable proportion of young adults in the second decade has acquired adult dimensions of external auditory canal diameters suggesting that the development of external auditory canal does not extend beyond adolescence. In the advanced age groups the canal diameters that are encountered are of smaller dimensions in comparison to the relatively younger adult (middle age groups) population. The higher scores encountered in the pediatric age groups may be due to an increased production of wax that is seen with this age group due to the increased sebum production seen among them as has been discussed previously but may also be due to the smaller external auditory canal diameters seen among this age group leading to impacting and retaining the wax that is being produced. Despite exhaustive perusal of otolaryngological literature, no references were found to be available regarding the range of diameter of the external auditory canal, though length of the canal enjoys a consistent mentioning in all standard text books.

SEX

The influence of sex on the production and impaction of ear wax was no difference in either the production or impaction emerged. This finding is comparable to those of Cipirani C et al [6] who observed no sex difference in the production of cerumen and Jacobsen E [5] who observed that the decline in sebum production as age advances is almost same in males and females. It is also in accordance with the study conducted by Jaber MA and Amadee RG [7] who observed that no significant gender differences exist concerning impaction of ear wax.

LATERAL MIGRATION

Failure of lateral migration may result in cerumen accumulation in the external auditory canal (PWRM Alberti) [8] as skin migration laterally in the external auditory canal is believed to carry cerumen out of the external auditory meatus (Hanger HC et al) [9] . One of the reasons for decreased lateral migration phenomenon in the extreme age groups may be the narrow external auditory canal which might impede the peripheral movement of the epithelial cells of the canal thus restricting the extrusion of wax as observed by JD Wilkinson [10] . The narrow canal thus leading to impaction and hardening of the wax, bolus may also offer physical resistance to the migration of the intact as well as desquamated epithelium, further impeding the conveyor belt phenomenon. This might set in a vicious cycle; failure of lateral migration leading to impaction and the impacted wax plug further impeding lateral migration. Commonest way of migration is starting from the umbo (figure1) and least commonly from the handle of malleus as an epicenter.

Figure 1

Figure 1

Figure 2

Figure 2

Five laws of epithelial escalation which briefly summarized are (Magnoni A [73]).

1. Epidermis migrates on its “original plane” from the anterior to the posterior margin of the membrane and then along the canal wall to the exterior.
2. The epidermis over the membrana flaccida fans out over the canal wall.
3. The epithelium over the processus brevis proliferates in whorls to the superior part of the canal.
4. The progress is most rapid in the posterior inferior quadrant.
5. Epithelium does not proliferate from canal to drumhead.

TYMPANIC MEMBRANE AND CERUMEN PATHOPHYSIOLOGY

Integrity of tympanic membrane was found to have a role to play in leading to impacted ear wax but none in the production of ear wax. It is known that any manipulation in the deeper canal can lead to congestion of tympanic membrane and therefore, it appears that no significant importance can be attached to the congestion of membranes seen after removal of the impacted wax. It is possible that tympanic membrane afflictions may have a role to play in causing impaction of cerumen considering the importance of lateral migration phenomenon in cleansing the external canals of cerumen, as observed by PWRM Alberti [8] and Hanger HC et al [9] in their respective studies. It was shown by PWRM Alberti in his classic study that the epithelial migration always occur from the tympanic membrane to the canal wall and not vice versa. Similar observations were also made by Stinson WD [11] , while expounding his five laws of epithelial escalation. Alberti also showed that, in both the commonly and less commonly seen patterns of epithelial migration, tympanic membrane was the centre from which migration commenced, the umbo being the epicenter in the former pattern and the whole of the handle of the malleus being the epicenter in the latter pattern. It may be thus hypothesized that tympanic membrane pathologies may impede the phenomenon of lateral migration thus ramifying into cerumen impaction, especially in elderly age groups. It may not be superfluous to suggest that further studies employing different methodologies capable of providing more stable results are needed in order to elucidate the factors leading to wax impaction resulting from tympanic membrane anomalies.

SOCIO ECONOMIC BEHAVIORAL IMPLICATIONS IN EAR WAX PATHOPHYSIOLOGY

High cerumen scores were found to be associated in a significant manner with patients belonging to lower socioeconomical status as assessed by U Pareek classification [12] Though it would be difficult to prove any direct cause-effect association between the occupational circumstances and cerumen population, the dry, dusty and other disadvantageous working atmosphere to which the working class is exposed to may have a contributory role in enhancing the cerumen scores by increased production of sweat (ceruminous glands are nothing but modified apocrine glands i.e apocrine and eccrine activity) in the external auditory canal and thus resulting in accumulation of cerumen. Excessive sweating, stress, inflammation etc leading to an increased production of cerumen has also been observed by Burge SM et al [13] and Kramer M. [14] The high level of stress associated with the low socioeconomical groups, especially the farmer community may also play a contributory role as stress and emotive stimuli has been observed as enhancing the secretion of apocrine glands as they are under adrenergic control (Shelley W). [15] Habits and household practices also appeared to have some role to play in the cerumen physiology. The habituations that are

common in rural parlance such as pan chewing, tobacco chewing, smoking etc did not prove to play any significant role in the production of cerumen, either singly or in combination whereas it was interestingly observed that these habituations singly and in combination were significantly associated with non impaction of ear wax rather than with impaction. Though the exact role of smoking in the phenomenon could not be ascertained it may be hypothesized that the enhanced masticatory activity that is associated with the other two habituations may be playing a role as it has been observed by JD Wilkinson [10] and Edwards J et al [138] that mastification indeed aids the extrusion of cerumen from the external auditory canal. Habituation to alcohol was not demonstrated as a significant association. Household practices such as usage of Q tips(cotton tipped swabs, match sticks etc) to clean the external canals was found to be significantly associated with impacted ear wax This may be attributed to the fact that while attempting to clean the canals, the Q tips may actually dislodge the wax bolus more medially and thus impacting them.

MICROBIOLOGY

Ear wax indeed has got antimicrobial properties. These findings are in tune with those of Chai TJ and Chai TC [16] , Stone M and Fulghum RS [17] who in their respective studies endorsed the view that cerumen indeed has got bactericidal properties. It also agrees with the findings of Burtenshaw JML [18] who also identified cerumen to be having antimicrobial properties against some pathogenic bacteria. Megarry S et al [19] also in their study, showed cerumen to be having bactericidal and mycocidal effects. On the contrary Perry ET and Nichols AC [20] in their study did not find cerumen to be having any inhibitory effect on microbial growth. Campos A et al [21] refuted the view that cerumen has got any bactericidal activity and went on to show that if any, it in fact favors bacterial growth in vitro. Jankowski A et al [22] also were unable to attribute any antimicrobial properties to cerumen. The possible antimicrobial role attributed to cerumen may be due to the presence of saturated and long chain fatty acids present in cerumen and also due to the low pH of cerumen. Otolaryngological literature is replete with views favoring and disputing the antimicrobial role attributed to cerumen traditionally. Further studies using different methodologies capable of providing more stable results are needed in order to elucidate it. Staphylococcus epidermidis emerging as the most common organism isolated from the external canals of normal individuals, as observe by Reichard W [23]

OTITIS EXTERNA, OTOMYCOSIS AND KERATOSIS OBTURANS

The percentage of otitis externa among otolaryngological practice is estimated to be 3-10% (Cassissi N et al [24] the percentage of this entity associated with ear wax could not be retrieved in literature perused. The estimated percentage of otomycosis in otolaryngological practice in temperate countries is reported approximately as 10% of all otitis externa cases (Bojrab DI et al [25]). It is reported that the percentage may be higher in tropical climates. As is the case with wax associated otitis externa, the percentage of otomycosis associated with ear wax was also not found to be published in literature. Though cerumen is widely postulated to be having antibacterial and antifungal properties, it has also been identified to be associated with infection in otolaryngological literature (Denneny JC III [26]). The postulated antimicrobial properties of cerumen are due to it acting as an oily mechanical barrier to the ingress of microorganisms, getting secreted on to the skin where it dries and disappear destroying bacteria and fungi (Osborne JE et al [27] and Keane EM et al) . Other antimicrobial properties are the presence of long chain polyunsaturated fatty acids and low pH associated with cerumen (Denneny JC III et al [26]). Several reasons are postulated for otitis externa and otomycosis : the occlusive cerumen plug may retain moisture and may convert the usually acidic pH of the external auditory canal to a more alkaline one thus favoring the growth of microorganisms (Bojrab DI [25]). Another postulate is that the occlusive cerumen plug may result in local irritation leading to overzealous cleaning with one's fingernail or a foreign object thus abrading the canal skin causing a defect in the canal and allowing inoculation (Bojrab DI [25]) . Another postulated theory is a deficiency in the protein component containing IgA and lysozyme of cerumen in susceptible individuals. However, this seems unlikely that IgA or lysozyme have a very important antibacterial role in cerumen as both age in requires mobility to function, working best in body fluids. Another reason may be the presence of comorbidities such as diabetes mellitus or an immunocompromised state. Senturia have even advised a plan of hygiene with regular removal of cerumen to avoid recurrent episodes of otitis externa.

Keratosis obturan is an extremely rare condition [143] characterised by the accumulation of large keratin plugs in the osseous external auditory canal, resulting in severe otalgia and hearing loss. Although its aetiology in unknown,

faulty migration and chronic hyperemia have been implicated [144] as the possible aetiological factors. It usually occurs in young patients and associated with bronchiectesis and chronic sinusitis and usually occurs bilaterally [145] , though this involvement may not affect both the ears to the same extent [146] . Pressure from the accumulated keratin may over time, result in a remodeling of the bony canal [147] . After the keratin mass is removed, generalised widening of the osseous portion of the external canal such that the tympanic membrane and annulus 'standing out in relief" often is apparent [148],[149] . Keratosis obturans has been differentiated from external auditory canal cholesteatoma by Piepergerdes JC and associates. [145] External auditory canal cholesteatoma involvement in usually unilateral, occurs in older patients and is not associated with sinusitis or bronchiectesis. Cholesteatoma also causes focal erosion of the bony canal wall, usually in an inferior and posterior location [148] . Debridement of squamous debris is required to treat keratosis obturans, whereas treatment of cholesteatoma often requires its excision including that of the underlying diseased bone followed by reconstruction of ear canal and tissue grafting as indicated.

AGENTS TO LOOSEN IMPACTED CERUMEN

Four main methods are commonly used to facilitate wax removal: Syringing of the bolus, removal using a variety of wax curettes or wire loops, suction debridement and disintegration of the ceruminous mass by the administration of a ceruminolytic solution which should allow spontaneous egress of the disintegrated cerumen. This latter technique depends upon a successful disintegration of the wax plug, thereby reducing its natural integrity and allowing the smaller disintegrated particles to be removed from the ear by the normal migrating mechanisms.

There are 2 groups of proprietary preparations used for the purpose of ceruminolysis-those based on oils which soften the wax by dissolution and those based on aqueous systems, which normally contain a surface active agent for improved water miscibility (Fahmy S and Whitefield M [178]).

Against this background, agents that loosen cerumen seem to offer the only effective, relatively well-tolerated management alternative to physical removal. Indeed, softeners are often sufficient to treat mild cases of impacted cerumen, as well as reducing the need for surgical removal in more severe cases. [163] Softeners can be used in conjunction with syringing. However, there are no well designed, large, placebo controlled, double blind studies comparing the various agents and strategies to loosen impacted cerumen. Indeed, numerous factors conspire to complicate a systematic analysis aside from any pharmacological differences. Impacted cerumen clears completely in 5% of patients without any treatment, while a further 26% of patients show a moderate improvement after five days without treatment. [174] Moreover, numerous intrinsic and external factors seem to influence efficacy. In addition, patient education may be important to maximize outcomes. For instance, some patients might not apply the drops for long enough before syringing. Moreover, patients may not allow them to soak into the external meatus for long enough before standing up. [106] Despite these limitations, a number of papers purport to advocate other agents as effective treatments for cerumen removal. However, the evidence is often mixed and inconsistent. To take one example, docusate sodium (dioctyl sodium sulphosuccinate), widely used as a stool softener, offers a 'highly effective' means of removing cerumen. No side-effects emerged over five years' clinical experience. [175] However, in another study, [176] docusate sodium in maize oil did not offer any 'outstanding advantages' in aiding earwax removal compared to maize oil control. Indeed, the average volume of water used was higher in the active group compared to controls: 111 and 81 ml, respectively. Furthermore, 80% and 58% of the wax was easy to remove in the control and docusate sodium groups, respectively. Upon analyzing the comparative efficacy of four ceruminolytic agents, by taking into consideration 3 parameters (post ceruminolytic cerumen score, attempts of syringing required to extrude the cerumen mass post ceruminolytic use and appearance of the removed cerumen mass), 2% paradichlorobenzene emerged as the most superior ceruminolytic, closely followed by 10% sodium bicarbonate. 2.5% acetic acid fared moderately while normal saline emerged as the least efficacious ceruminolytic agent. The evidence surrounding the pharmacological management of impacted cerumen is inconsistent, and few conclusions can be drawn. There is clearly a need for a definitive assessment of the most effective pharmacological strategy for cerumen removal.

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