

A comparative study of ceruminolytic agents

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Abstract A prospective study was done to assess the efficacy of ceruminolytic agents, i.e 2% paradichlorobenzene, 10% sodium bicarbonate, 2.5% acetic acid and normal saline. All score 4 hard impacted ear wax cases in the adult population (>20 years) were accrued for the assessment of the relative efficacy. Upon analyzing the comparative efficacy of four ceruminolytic agents, by taking into consideration three 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.

Keywords Ceruminolytic agents · 2% paradichlorobenzene · Impacted wax · Cerumen score · 10% Sodium bicarbonate · Acetic acid

Introduction

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, hair and insects. Despite this physiology, impacted cerumen is a major cause of primary care consultation and common co-morbidity in ENT patients, the elderly, infirm [1] and people with mental retardation [2]. Moreover management of impacted cerumen in example, diabetes and immunocompromised subjects can pose problems for secondary care physicians [3]. The treatment of wax impaction has been a controversial subject for many centuries. The conceptualization of softening ear wax with the specific intention of facilitating removal dates back to the 18th century [4]. In the early 18th century Grau [5], in his dissertation on wax, described the use of olive oil in the treatment of this condition. More than 100 years later, Toynbee [6] used a solution of “carbonate of soda in water, dropped into the ear for some days” prior to syringing with warm water, while Politzer [7] instilled 10 drops thrice daily of a warmed solution of soda and glycerin. A multitude of preparations have since been recommended by various authors and this diversity of options has been compounded by the availability of a large range of commercially prepared formulations. Several studies assessing the epidemiology of impacted cerumen show that the condition is common. For example, one study shows that between 2% and 6% of the general population suffers from impacted cerumen [2], whereas another study shows the incidence to be between 5–17% [8]. Despite this, 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 treatments 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. Physicians are supposed to follow the edicts and

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principles of evidence-based medicine and clinical governance. Currently in patients with impacted cerumen, the lack of evidence makes this impossible [9].

Materials and methods

A total number of 278 patients with symptoms related to ear wax and a control group of 28 patients with no ear wax or wax-related symptoms attending the ENT OPD from September 2005 to August 2007 were accrued for the study (Table 1, Fig. 1). Among the 278 patients, 261 patients with impacted/non-impacted ear wax were studied for the assessment of all parameters in the purview of this study, whereas 17 patients with ear wax-related manifestations such as otitis externa (12 patients), otomycosis (3 patients)

and keratosis obturans (2 patients) were accrued only for the calculation of the percentage of these entities associated with ear wax, total incidence of ear wax in the general population and also for assessment of the microbiological flora associated with otitis externa and otomycosis entities. All patients were informed about the nature of the study and consent was obtained. All patients were interviewed with a detailed proforma and history and examination findings were entered in detail in the proforma. The scoring pattern was 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). This scoring method was adapted from the study conducted by Carr et al. [10]. All score 4 hard impacted ear wax cases in the adult population (>20 years) were accrued for the assessment of the relative

Table 1 Ear-wise distribution of impacted and non-impacted ear wax in 261 patients (excluding 34 ears of otitis externa, otomycosis and keratosis obturans and 39 ears with cerumen score 1)

Age group (Years)	Impacted			Non-impacted		
	Right	Left	Bilateral	Right	Left	Bilateral
0–10	8	1	29	2	6	18
11–20	5	1	19	3	6	30
21–30	10	2	6	11	8	19
31–40	2	5	2	7	2	18
41–50	5	6	1	4	5	17
51–60	3	5	9	3	1	4
>60	-	-	14	-	-	-
Total	33	20	80	30	28	106

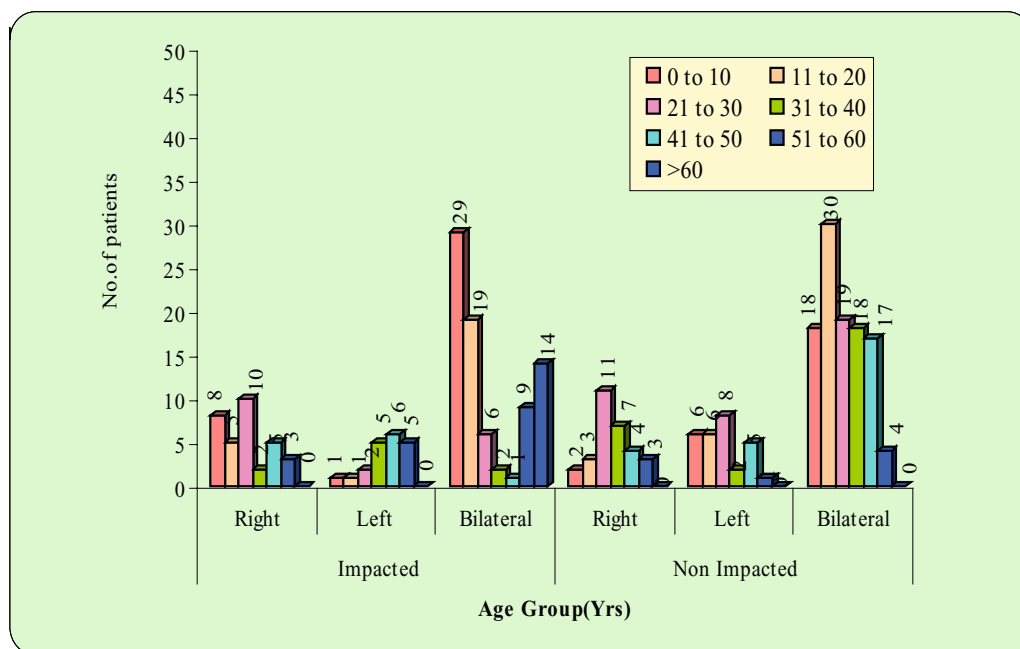


Fig. 1 Ear-wise distribution of impacted and non-impacted ear wax in 261 patients

efficacy of 4 wax solvent formulations; conventional 2% paradichlorobenzene ear drops, 10% sodium bicarbonate drops, 2.5% acetic acid drops and normal saline. A total number of 56 patients (82 ears) were assessed in this group. Selection of patients for assessment of wax solvent efficacy was based on the criteria that unless the ear wax is hard and completely occlude the external auditory meatus; no wax solvent is required prior to syringing. Only ears containing such wax were included in the trial. These drops were regularly alternated with every successive patient receiving 2% paradichlorobenzene, 10% sodium bicarbonate, 2.5% acetic acid and normal saline formulations. The patients/parents of patients receiving the ear medications were instructed in detail about the institution of the drops. They were advised to lie down with the ear in which the drops are to be instilled topmost and after straightening the ear canal by pulling the pinna upwards and backwards. They were advised to instill 3 drops each into the ear canal and then press the tragus inwards for several times for better action of the medications by displacement method. They were then advised to remain in that position for 5 min following which the method was to be repeated in the other ear also, in case medications are prescribed for that ear also. Patients were advised to use the drops thrice daily for 5 days and were strictly advised against instillation of any home remedies into the ear and also against any kind of physical manipulation of the ear wax/ears. On the 5th day the patients were reviewed and the cerumen score assessed by otoscopic examination and this was recorded down. Then the ears were syringed using syringe with 20 ml of normal saline per each attempt of syringing. The number of syringing attempts required to remove the ear wax completely was noted down. At the end of each attempt, the ear/

ears were examined with otoscope to assess the clearance of wax. The end-point was adopted as complete visualization of tympanic membrane. In any event not more than three attempts were required to remove the ear wax from any ear. The appearance of the removed ear wax mass was also observed and recorded. The relative efficacy of ear wax solvents were assessed and analyzed by taking into consideration these three parameters, namely the post ear drops cerumen score, the number of syringing attempts required to extrude the ear wax completely and the post-removal appearance of the ear wax. Any symptoms/complications associated with wax solvent ear drops were also asked for and were duly recorded if encountered. Their post-observation period cerumen score was observed and recorded. According to the post-observation period cerumen score they were then treated by curetting, simple syringing using syringe employing 20 ml of normal saline per syringing attempt or a course of conventional wax solvent ear drops followed by curettage or syringing as described above, but these treatment modalities were also not included in the study pattern as these were also undertaken purely for therapeutic purposes.

Observation

Out of the 261 patients (522 ears) studied, 39 ears where the cerumen score was 1 (no wax) was not included in either groups of impacted or non-impacted ear wax. In the remaining 483 ears, 213 ears were having impacted wax where as non-impacted wax was seen in 270 ears. In the impacted ear group 33 patients had impacted wax only their right ears (33 ears); 20 patients had impacted wax only in their left

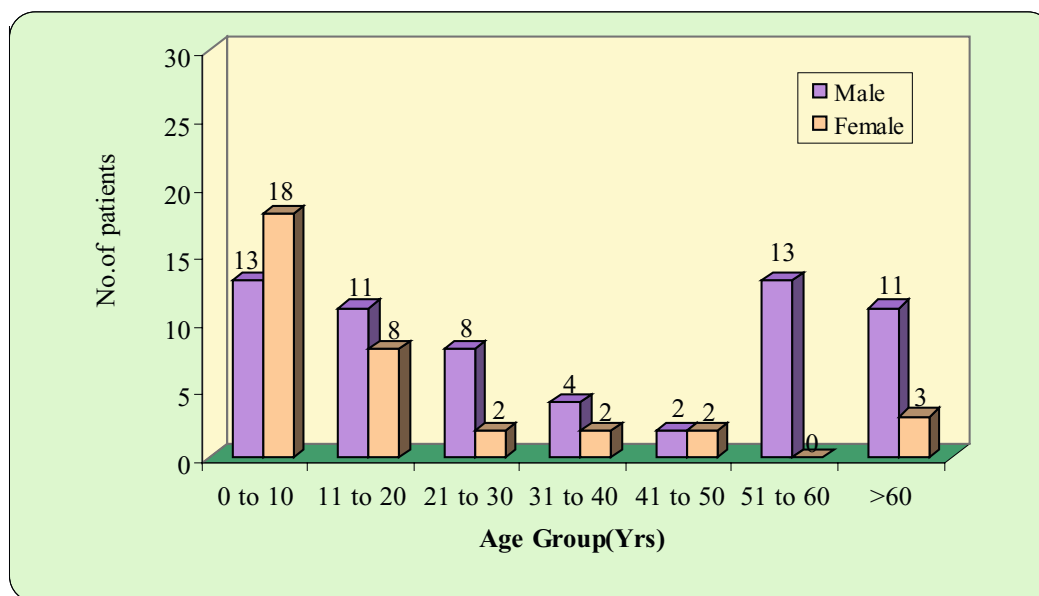


Fig. 2 Age-wise and sex-wise distribution of patients with only impacted ear wax

ears; 80 patients had both ears (160 ears). In patients with non-impacted ear wax, 30 patients had only their right ears involved (30 ears) where as 28 patients had their left ears (28 ears) with non-impacted ear wax. Non-impacted wax in both ears was present in 106 cases (212 ears). Bilateral ears with impacted wax were seen maximum in 0–10 years age group (29, 36.25%). On comparing Table 1 and Table 3,

it is observed that all the patients in >60 year age group (14 patients) had impacted ear wax in bilateral ears. A total number of 97 patients (62 males and 35 females) with only impacted ear wax were stratified into different age groups and were statistically analyzed. Maximum number of patients with impacted ear wax was found in the 0–10 year age group (31.96%), with a steady decrease in the incidence

Table 2 Age-wise and sex-wise distribution of patients with only impacted ear wax (excluding 36 patients with one ear having impacted and the other ear having non-impacted wax)

Age group (Years)	Male			Female			Total N	Percentage (%)	
	n	%		n	%				
		Out of 62	Out of 97		Out of 35	Out of 97			
0–10	13	20.97	13.40	18	51.43	18.56	31	31.96	
	p-value	0.05, Not significant, p>0.05							
11–20	11	17.74	11.34	8	22.86	8.25	19	19.59	
	p-value	0.61, Not significant, p>0.05							
21–30	8	12.90	8.25	2	5.71	2.06	10	10.31	
	p-value	0.48, Not significant, p>0.05							
31–40	4	6.45	4.12	2	5.71	2.06	6	6.19	
	p-value	1.00, Not significant, p>0.05							
41–50	2	3.23	2.06	2	5.71	2.06	4	4.12	
	p-value	0.62							
51–60	13	20.97	13.40	0	0.00	0.00	13	13.40	
	p-value	0.008, Significant, p<0.05							
More than 60	11	17.74	11.34	3	8.57	3.09	14	14.43	
	p-value	0.37, Not significant, p>0.05							
Total	62	63.92		35	36.08		97		

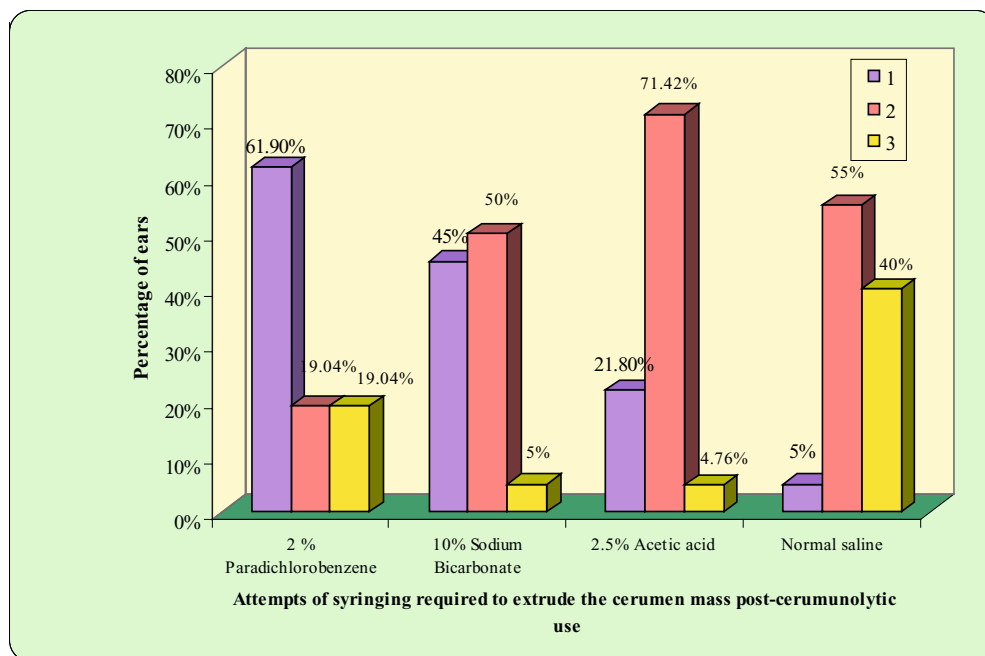


Fig. 3 Comparative efficacy of ceruminolytic agents

of impaction as age advances and then a sudden increase in elderly age groups. The male and female population in individual age groups were statistically analyzed and the frequency of distribution of impaction of ear wax for both sexes were found to be non-significant in all age groups except in 51–60 years age group.

The comparative efficacy of 4 ear wax solvents namely 2% paradichlorobenzene, 10% sodium bicarbonate, 2.5% acetic acid and normal saline were studied. 14 patients were assessed with each formulation (21 ears with 2% paradichlorobenzene, 21 ears with 2.5% acetic acid and 20 ears each with 10% sodium bicarbonate and normal saline). The pre-drops cerumen score was 4 with impaction in every ear. The post-drops cerumen score in every ear was 4. 2% paradichlorobenzene appears to be maximally efficacious as a ceruminolytic agent with maximum successful first attempt syringing post ear drops (62% of ears) where it was used and also as the ceruminolytic agent producing cerumen loosening in the highest percentage of ears (90.47%). 10% sodium bicarbonate came next in efficacy with a successful first attempt syringing in 45% of years where it was used and also as the ceruminolytic agent producing cerumen loosening in 75% of ears where it was used. 2.5% acetic acids comes next with a maximum successful second attempt syringing 71.5% ears and resulting in wax loosening in 57.14% ears. Normal saline fared as the least efficacious ceruminolytic agent requiring a third attempt syringing in 40% of ears where it was used and with the wax mass remaining compact in 60% ears where it was used. These therapeutic results were statistically analysed and were found to be significant.

Discussion

Manifestations related to ear wax is commonly encountered in otolaryngological practice and a considerable amount of time is spent by otolaryngologists in the removal of impacted or non-impacted cerumen in the external auditory canal. It is a matter of considerable interest that ear wax formation which is very much a part and parcel of the 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 external auditory canal and whatmore, 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.

Incidence

At the outset of the study one of the aims were to assess the incidence of ear wax in the rural population of Vidarbha. The study being a hospital based one and out hospital being a rural establishment, though it caters to the rural population of Vidarbha in general, its primary beneficiaries are the rural folk of Wardha District and this being the case, the incidence of ear wax in the rural population of Wardha District is being calculated. Though this may not be a completely meticulous approach, it is perceived that this incidence may be a reflection of the incidence of ear wax in the rural population of Vidarbha. The incidence of ear wax among the rural population of Wardha district was thus calculated by employing the formula

$$\text{Incidence} = \frac{\text{Total no of cases of a disease}}{\text{Mid-year population}} \times 100$$

The denominator was taken as the mid year population of Wardha district at the time of completion of the study. Thus incidence was calculated as

$$\frac{278}{1344009} \times 100 = 0.02\%$$

This evidences that symptomatic ear wax accumulation is a relatively less common entity in the rural population of Wardha district/Vidarbha region.

Sex

The influence of sex on the production and impaction of ear wax was assessed and upon age-wise comparison between males and females no difference in either the production or impaction emerged. This finding is comparable to those of Cipirani et al. [11] who observed no sex difference in the production of cerumen and Jacobsen [12] who observed that the decline in sebum production as age advances is almost same in males and females. But at the same time in the study conducted by Chiang [13], it was inferred that there are striking sex differences in the production of sebum as influenced by hormonal stimuli. As secretion of cerumen is not only the product of the ceruminous glands, but also of the sebaceous glands of the ear canal, it would be necessary before ruling out or ratifying the influence of sex hormones, to explore possible variations in the phases of the menstrual cycle and any possible correlation with the production of cerumen.

Nature of ear wax

Regarding the physical characteristics of cerumen, it was observed in the present study that all non-impacted ear wax samples were soft in consistency and of the wet type in an overwhelming 97.4% of samples, the remaining being the dry type. All the samples were brown in color except one.

Table 3 Comparative efficacy of ceruminolytic agents

Drops	Pre-drops cerumen score	Post-drop cerumen score				Attempts of syringing required to extrude the cerumen mass post-ceruminolytic use			Appearance of the removed cerumen	
		1	2	3	4	1	2	3	Loosened Mass	Compact Mass
PCB (21 ears)	4	-	-	-	21	13 (61.90%)	4 (19.04%)	4 (19.04%)	19 (90.47%)	2 (9.53%)
10% Sodium bicarbonate (20 Ears)	4	-	-	-	20	9 (45%)	10 (50%)	1 (5%)	15 (75%)	5 (25%)
2.5% AA (21 ears)	4	-	-	-	21	5 (21.80%)	15 (71.42%)	1 (4.76%)	12 (57.14%)	9 (42.86%)
Normal Saline (20 ears)	4	-	-	-	20	1 (5%)	11 (55%)	8 (40%)	8 (40%)	12 (60%)
	² -value	27.02							13.06	
	p-value	0.0001, Significant							0.004, Significant	

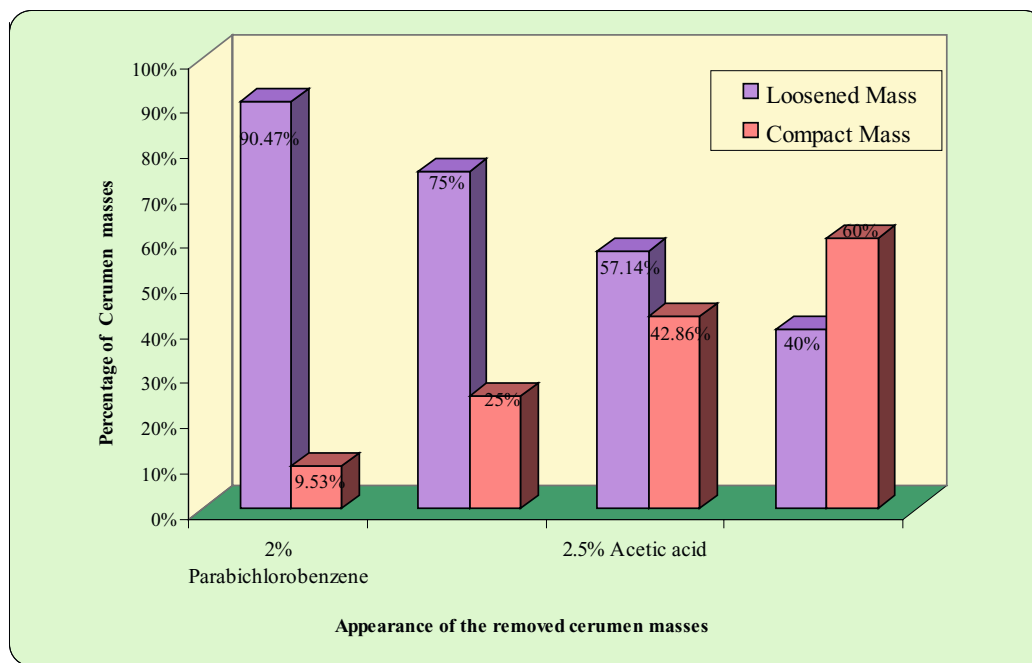


Fig. 4 Appearance of removed cerumen mass post-ceruminolytic use

Approximately 70% of the samples were profuse in quantity, the remaining being moderate or scanty. The impacted wax samples were invariably found to be heard consistency dry and profuse. 97% of the impacted wax samples were blackish in color, the remaining being of brown color. The majority of the non-impacted wax being wet in nature was contrary to the popular view that ear wax in Asian races is generally of the dry type. But it may be born out by Matsunaga’s [14] observation wet among Asian population there may be a marked variation in the nature of cerumen types whereas there is little variation in the cerumen types among Caucasians and Negroes where the death cerumen type predominates. In the present study, the finding of brown color

predominating wet cerumen samples is comparable to that of Matsunaga [14]. The preponderance of black color and dry nature among impacted cerumen samples may be due to the darkening of the color and dessication on prolonged exposure to air in the external auditory canal, a similar observation being made by Matsunaga’s [14].

Ceruminolytic agents

A considerable amount of time is devoted by ENT surgeons in the removal of impacted ear wax in the external auditory canal. 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 two 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 [15]. The formulations compared in this study are 2% paradichlorobenzene with 5% chlorbutol and 10% turpentine oil, which is an oil based preparation and 10% sodium bicarbonate, 2.5% acetic acid and normal saline which are aqueous preparations. Three parameters were considered in assessing the efficacy of the formulation. The post-ear drops score, the attempts of syringing required to extrude the ceruminous mass and the appearance of the removed ceruminous mass. There were no difference between all the four ceruminolytic agents as far as the post-ear drops score was concerned; in all cases the score remained 4. But the ceruminous mass in the EAC has been softened as compared to the hard impacted cerumen prior to administration of drops. This was comparable to the study conducted by Keane et al. [16] according to whom there was no significant difference between 2% paradichlorobenzene and 10% sodium bicarbonate but inferred that both were significantly better than no treatment. Considering the second parameter (attempts of syringing), 2% paradichlorobenzene was found to be most effective with maximum no of ears getting cleared of cerumen mass with a single attempt of syringing. 10% sodium bicarbonate was next in effectiveness followed by 2.5% acetic acid. Normal saline was found to be the least effective ear wax solvent in this regard. Considering the third parameter (appearance of the removed cerumen) also 2% paradichlorobenzene was found most superior closely being followed by 10% sodium bicarbonate and thereafter by 2.5% acetic acid with normal saline again emerging as the least effective. 2% Paradichlorobenzene coming as a very effective ceruminolytic agent makes this study comparable to that by Dummer et al¹⁷ who compared audax ear drops (50% choline salicylate, glycerol and 0.5% chlorbutol) with 2% paradichlorobenzene drops (cerumol) and found out that both were good ceruminolytics with equal effectiveness. It is also comparable to the study conducted by Fraser et al. [18] who found 2% paradichlorobenzene to be significantly better than 10% sodium bicarbonate as a ceruminolytic agent. He also observed that 2% paradichlorobenzene was in fact better than a number of other ceruminolytic agents such as 5% dioctyl sodium sulphosuccinate and 10% triethanolamine polypeptide oleate condensate. 2% paradichlorobenzene efficacy as a ceruminolytic agent as revealed in this study is also comparable

to the in vitro study conducted by Mehta [19] who demonstrated 2% paradichlorobenzene to be superior to 5% urea hydrogen peroxide and 10% triethanolamine polypeptide oleate condensate and comparable to ear wax drops (arachis oil, almond oil, rectified camphor oil). The finding that 10% sodium bicarbonate is the second most effective ceruminolytic agent among the agents studied is comparable to the in vitro study conducted by Robinson and Hawke [20] who demonstrated that a 10% sodium bicarbonate solution is most effective in producing disintegration of wax plug in vitro. But the in vitro study conducted by Bellini [21] demonstrated 10% sodium bicarbonate to be more effective than 2% paradichlorobenzene in producing disintegration of wax plug in vitro. Carr MM and Smith RC [22] have compared 10% sodium bicarbonate and 2.5% aqueous acetic acid observed no significant difference between the ceruminolytic efficacies of the two preparations. The efficacy of 10% sodium bicarbonate as evidenced by this study is further bolstered by the fact that Stalwarts like Toynbee [6] in 1860 and Politzer [7] in 1883 has recommended a bicarbonate solution pretreatment prior to ear syringing and suggested that it be used in young children or uncooperative patients for 14 applications to obviate the need for debridement. Other authors who have recommended sodium bicarbonate as a valuable ceruminolytic are Hall and Colman (1975) [23], Ballantyne and Groves (1978) [24], Mawson and Ludman (1979) [25] and Maran (1983) [26]. In this study it was observed that 2.5% acetic acid was the only ceruminolytic which was shown to produce irritation of the ear canal. Though Robinson and Hawke [20] has reported an irritant properly with 2% paradichlorobenzene no such occurrences was observed in this study. The study conducted by Hinchcliffe R [27] on military recruits has also reported of such an irritant feature of 2% paradichloro benzene but the general practitioner clinical trials in 1967 showed that 2% paradichlorobenzene did not produce any discomfort in 95% of cases where it was used.

Conclusion

Upon analyzing the comparative efficacy of four ceruminolytic agents, by taking into consideration three 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.

References

1. Freeman (1995) Impacted cerumen: How to safely remove ear wax in an office visit. *Geriatrics* 50:52–53

2. Crandwell, Roeser (1993) Incidence of excessive impacted cerumen in individuals with mental retardation: A longitudinal investigation *AMJ Ment Retard* 97:568–74
3. Zikk, Rapoport, Himelfarb (1991) Invasive external otitis after removal of impacted cerumen by irrigation. *N Eng J Med* 325:969–70
4. Lyndon, Roy, Grillage (1992) A comparison of the efficacy of two ear drop preparations (Audax & Earex) in the softening and removal of impacted earwax. *Curr Med Res Opin* 13:21–25
5. Grau (1705) *Dissertatio Medica Physiologica De Cerumine*. Jena
6. Toynbee J. (1860) *Diseases of the Ear*. Blanchard and Lea, Philadelphia, pp 82–87
7. Politzer A. (1883) *Diseases of the Ear and Adjacent organs*, Henry C. Lea's Son and Co; Philadelphia, pp 580–583
8. Roeser, Ballachanda (1997) Physiology, pathophysiology and anthropology/epidemiology of human ear canal secretions. *J. American Acad Audiol* 8(6):391–400
9. Colin Kidd (2006) *The forging of races: Race and scripture in the Protestant Atlantic World, 1600–2000*: Cambridge University Press. pp 4
10. Carr, Smith (2001) Ceruminolytic efficacy in adults versus children. *J Otolaryngol* 30:154–156
11. Cipriani, Taborelli, Gaddia (1990) Production rate and composition of cerumen. Influence of sex and season. *Laryngoscope* 100:275–276
12. Jacobsen (1985) Age related changes in sebaceous wax ester secretion rates in men and women. *J Invest Dermatology* 85: 483
13. Chiang, Lowry, Senturia (1955) Microchemical studies on normal cerumen. I. The lipid and protein content of normal cerumen as affected by age and sex. *Laryngoscope* 65: 927
14. Matsunaga, Itoh, Suzuki and Sugimo (1954a) Incidence and inheritance of the ear wax types. *Sapporo Med J* 6:368
15. Fahmy and Whitefield (1982) Multicentre clinical trial of Exterol as a cerumenolytic. *Br J Clin Pract* 36:197–204
16. Keane, Wilson and McGrane (1995) Use of solvents to disperse ear wax *Br J Clin Pract* 49:71–72
17. Dummer, Sutherland and Murray (1992) A single –blind, randomised study to compare the efficacy of two ear drop preparations ('Audax' and Cerumol) in the softening of ear wax. *Curr Med Res Opin* 13:26–30
18. Fraser (1970) The efficacy of wax solvents: in vitro studies and a clinical trial. *J Laryngol Otol* 84:1055–1064
19. Mehta (1985) An in vitro comparison of the disintegration of human earwax by five cerumenolytics commonly used in general practice. *Br J Clin Pract* 39:200–203
20. Robinson and Hawke (1989) The efficacy of ceruminolytics: everything old is new again. *J Otolaryngol* 18:263–267
21. Bellini, Terry and Lewis (1989) An evaluation of common ceruminolytic agents: an in vitro study. *Clin Otolaryngol* 14:23–25
22. Carr, Smith (2001) Ceruminolytic efficacy in adults versus children. *J Otolaryngol* 30:154–156
23. Hall, Colman (1975) *Diseases of the external ear*. In: *Diseases of the Throat, Nose and Ear*, 11th ed. Churchill Livingstone, London, pp 244–245
24. Ballantyne, Groves (1978) Miscellaneous conditions of the ear. In: *A Synopsis of Otolaryngology*, 3rd ed. John Wright & Sons Ltd, Bristol, pp 90–91
25. Mawson, Ludman (1979) Diseases due to trauma or physical agents. In: *Diseases of the Ear*, 4th ed. Edward Arnold, Chicago, pp 240–241
26. Maran (1983) Description of specific diseases of the ear. In: *Otorhinolaryngology*. University Park Press, Baltimore, pp 21–22
27. Hinchcliffe (1955) *British Medical Journal* 2:722