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Short Communication

Distribution of ear drops in normal ears

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Abstract
Ear drops are prescribed widely with little thought for the distribution inside the ear canal. This study compares the distribution of water and oil based drops. The results indicate that, under the test conditions, the penetration of ear drops is extremely variable. Water provided the greatest overall coverage, while the most viscous drops fared worst. It is suggested that in diseased ears even poorer penetration may result, which may explain the lack of response in some circumstances.

Introduction

Ear drops are prescribed frequently in both hospital and general practice for the treatment of various ear conditions (Browning *et al.*, 1988). The cost in this hospital is approximately £4000 per annum. The most commonly prescribed drops are gentamicin, hydrocortisone (Gentisone, HC®), framycetin, gramicidin, dexamethasone (Sofradex®), neomyocin, polymyxin B, hydrocortison (Otosporin®), clioquinol, fluemethasone (Locorten-Vioform®), for the treatment of chronic otitis media and otitis externa.

Browning *et al.* (1983) in a controlled trial of 75 patients with active chronic otitis media, using three treatment regimens, including aural toilet and insufflation of boric acid and iodine powder, topical antibiotics and systemic antibiotics depending on the infecting organism, found no significant difference between the treatment groups over the four week period of the trial. They did not feel that there was any problem with access as a number of the patients had open mastoid cavities. It is important to know the distribution of the drops as this could have a significant effect on the resolution of the underlying condition.

No clear guidelines exist for the use of ear drops. The data sheets prepared by the manufacturers merely say to instil two or three drops into the ear, two to three times daily. The British National Formulary suggests patients should lie on their side, affected ear uppermost for a period of 10 minutes (British National Formulary, March 1990). Most medical practitioners give additional verbal instructions to the patient.

It appears that no previous study has looked at the distribution of ear drops following instillation.

The aims of this study were to determine under ideal conditions the distribution of ear drops in normal ears and to see if the viscosity of the drop had any bearing on the result.

Materials and methods

Forty-five normal adult ears were studied. Otoscopy was performed and any wax removed. Each ear was then given a liberal dusting with Povidone powder, and the ear re-examined to check that the tympanic membrane had been completely covered by powder. A standard three drops of either water (as a control) in Locorten-Vioform dropper bottle, Gentisone HC, or Locorten-Vioform, were then placed in the ear under study with the volunteer lying down on their side. The cartilagenious meatus being straightened manually as described by Fitzgerald O'Connor (1987). After instillation of the drops the volunteer remained lying for one minute. The ear was then re-examined otoscopically and the distribution of the drops was assessed. The areas where powder remained on the tympanic membrane were recorded by a line drawing and expressed as a percentage.

The study was then repeated using a further 30 ears, Gentisone HC and Locorten-Vioform drops, and observations made at 5 and 10 minutes, to see if any change in distribution occurred.

The viscosity of all solutions was tested in the quality assurance laboratory, using a suspended level viscometer, at both 20°C and 37°C, the result being recorded in 'centi Stokes', (a unit of kinematic viscosity corresponding to dynamic viscosity of one poise* and density of 1 gram per cc). The results are shown in Table I.

*Poise = unit of dynamic viscosity, such that shear of 1 dyne/cm^2 causes a velocity change of 1 cm/s for each cm transverse to plane of shear.

Results

With the volunteer lying on their side for one minute, the largest area of the tympanic membrane was covered by the least viscous solution—water, whilst the most vis-

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TABLE I
DROP VISCOSITY (CENTI-STOKES)

	20°C	37°C
Water	1.11	0.91
Gentisone HC	1.52	1.18
Locorten-Vioform	72.00	54.70

TABLE II
AREA OF TYMPANIC MEMBRANE COVERED BY DROPS AT ONE MINUTE

Drops	No.	Cover None	<50%	>50%	Complete
Water	15	0	5	5	5
Gentisone HC	15	0	6	7	2
Locorten-Vioform	15	3	8	3	1

TABLE III
AREA OF TYMPANIC MEMBRANE COVERED BY DROPS AT TEN MINUTES

Drops	No.	Cover None	<50%	>50%	Complete
Gentisone HC	15	0	4	6*	5
Locorten-Vioform	15	5	7	2	1

*One patient showed a minor change in distribution.

cous provided complete cover in only one ear, but there was great variation of distribution for all types of drop (Table II). When over 50 per cent (but less than complete) cover of the tympanic membrane was observed, powder remained in the attic in all cases (15 out of 45), (Figs. 1 & 2). When less than 50 per cent of the ear was covered, drops were located in the antero-inferior quadrant of the tympanic membrane (19 out of 45), (Figs. 3 & 4). The drops did not reach the tympanic membrane in three cases, all of which had Locorten-Vioform drops instilled.

The results for the 5 and 10 minutes observations (Table III) show no major difference to the one minute result. Only one patient showed a small change in the distribution of the drops between 5 and 10 minutes. This was a tympanic membrane which at 5 minutes had remnants of powder in both attic and inferior parts, but at 10 minutes had only powder remaining in the attic. No other ear showed any change at all between 5 and 10 minutes.

All patients in whom full cover of the tympanic membrane was observed had achieved this at 5 minutes.

Discussion

This study used normal ears, where an ideal situation was created, by having the subject lying on their side for up to 10 minutes. This does not reflect the disease situation, where the presence of canal wall oedema, central tympanic membrane perforation, a mastoid cavity, or the patients themselves instilling the drops, may modify the distribution of the ear drops.

The study shows considerable variation in the pen-

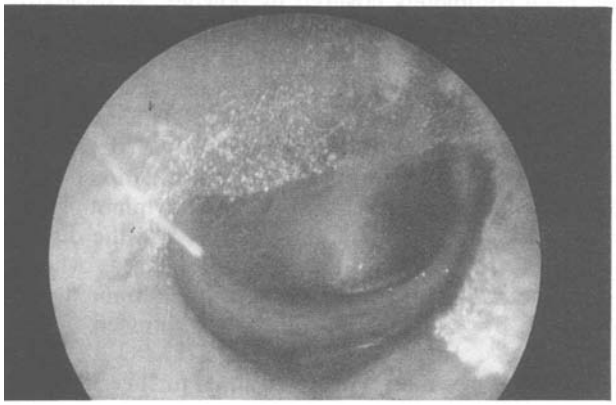

FIG. 1
Right ear. Powder unchanged in attic region.

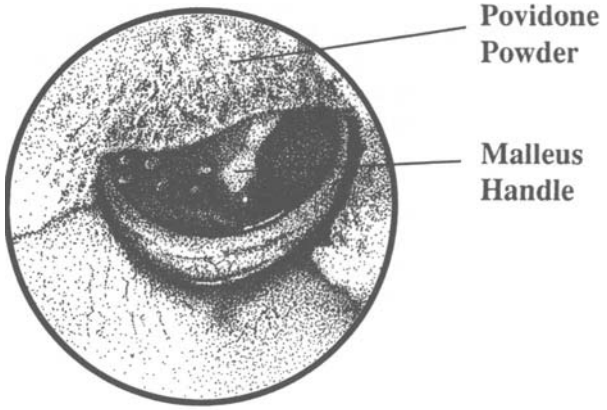

FIG. 2
Line drawing of figure 1.

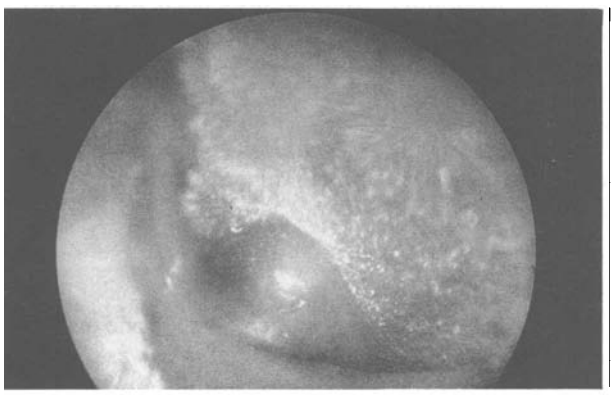

FIG. 3
Left ear. Powder disturbed in antero-inferior quadrant only.

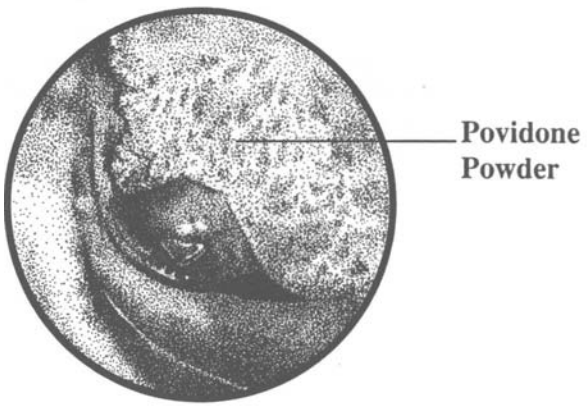

FIG. 4
Line drawing of figure 3.

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etration of ear drops. A number of factors may be important in this respect. The viscosity of the different drops will affect their ability to spread over a given surface. The amount of the drops given is difficult to control in normal practice, as ear drops are usually self administered, and the size of drop varies according to the internal diameter of the nozzle. No uniform guidelines exist from the manufacturers.

In contrast to this, the more viscous drops may not run out of the ear as quickly as the less viscous, and may therefore be more effective on the parts they reach.

The length of time a subject remains on their side does not seem to influence the distribution of the drops. In addition to this it is questionable whether patients would actually comply with such a length of time, over the whole period of use of the drops.

The advice given in the British National Formulary, for the patient to remain lying on their side for 10 minutes would seem to be unnecessary, as penetration of drops does not appear to increase with time.

Since the study has been completed our patients are now instructed to instil the drops in the manner of the protocol, to fill the ear with the drops and massage the external auditory meatus.

The results of this study suggest that the standard amounts of drops used in normal ears, under ideal conditions, do not cover the tympanic membrane in a uniform manner. Further study will be needed to examine the distribution of ear drops in the presence of disease.

Key words: Ear drops

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