Aural and Nasal Temperature Measurements Using an Infrared Thermometer *vs* Conventional Axillary and Oral Measurements

Fadlullah Aksoy, Yavuz Selim Yıldırım*, Bayram Veyseller and Hasan Demirhan

Haseki Research and Training Hospital, Department of Otorhinolaryngology and Head and Neck Surgery, Istanbul, Turkey

Abstract: *Introduction and Aim*: The aim of the present study was to compare aural temperature measurements with conventional methods (axillary and oral) in patients with unilateral tympanic membrane perforation or myringosclerosis. The study also aimed to test the potential nasal use of infrared thermometer.

Materials and Methods: Forty-four adult patients with monoaural tympanic membrane perforation and 29 adult patients with monoaural myringosclerosis were included in this prospective study conducted between June 2007 and November 2008. The contralateral ears of the patients were normal. Inter-aural, axillary, oral and nasal temperature measurement results of the patients were compared.

Results: Similar measurement results were obtained from the two ears in patients with monoaural perforation (P = 0.7780, SD± 0.3189). Similarly, in patients with monoaural myringosclerosis, no statistically significant difference was found between the measurements from the normal and diseased ear (P = 0.9346, SD± 0.2244). Measurements obtained by using nasal infrared thermometer was significantly lower compared to aural, axillary and oral measurements ($p<0.0001$).

Conclusion: Perforation of tympanic membrane and myringosclerosis are usually asymptomatic and their presence does not effect the aural temperature measurements done by an infrared tympanic thermometer. Nasal temperature measurement by an infrared thermometer is not a reliable method, as it gives significantly lower results than actual body temperature.

Keywords: Temperature measurement, infrared ear thermometry, digital thermometer, mercury in-glass thermometer, thermistor, fever measurement.

INTRODUCTION

Fever is a quite sensitive indicator of infectious disease. The thermometer, which was developed more than a century ago, measures heat conducted from the skin or mucous membranes to an adjacent probe. Following the description of infrared thermometry by Hughes *et al*. (1985), non-contacted infrared tympanic thermometry (ITT) has been added to the display of clinical techniques [1]. This method provides a non-invasive temperature reading within seconds and requires minimum cooperation. It is easy to use, does not require the removal of the cloths and mucous membranes are not directly contacted. The method is well accepted by pediatric patients, adults, parents and nurses at emergency room, outpatient clinic and hospital settings [2].

The blood supply to the ear canal and the tympanic membrane is from the maxillary and middle meningeal arteries, which are branches of the external carotid artery. Because both the ear canal and the tympanic membrane have no inherent metabolic activity, the local temperature is primarily determined by their respective blood supply. Therefore, the tympanic membrane temperature should closely represent the hypothalamic temperature [3].

*Address correspondence to this author at the Haseki Eğitim ve Araştırma Hastanesi, Kulak Burun Boğaz Kliniği, 34089 Fatih/Istanbul, Turkey; Tel: +90 212 5294400, Ext: 1286; Fax: +90 212 5103701;
E-mail: dryavuzselim@yahoo.com

The mercury glass thermometer is among the most frequently used temperature measurement tools. Currently, electronic thermometers have replaced the mercury glass thermometers in clinical settings. These electronic ear thermometers measure the radiant heat emitted from the tympanic membrane and external ear canal [4]. These measurements may be influenced by the following factors: presence of otitis media or external otitis, canal wall down surgery and a narrow external ear canal (with or without excessive hair) [2,5]. Such factor may result in inaccurate results. On the other hand, according to several studies, presence of effusion (otitis media with effusion) or ventilation tube does not effect ITT results [6,7].

The aim of the present study was to compare simultaneous temperature measurements obtained from the diseased and normal ears of patients with unilateral tympanic membrane perforation or myringosclerosis (with intact contralateral ear), using an infrared tympanic thermometer, which is a practical, convenient and non-invasive device requiring minimum cooperation. We also aimed to compare these with the results of classical body temperature measurement methods: oral measurements using a digital thermometer and axillary measurements with a mercury thermometer.

Nasal region is a promptly visible and accessible part of the body and it is more vascular than ears. We also compared nasal temperature measurements done by using an infrared

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thermometer with simultaneous aural, axillary and oral measurements, in order to examine its potential clinical use.

MATERIALS AND METHODS

Selected patients that admitted to the otorhinolaryngology outpatient clinics of Haseki Training and Research Hospital between June 2007 and November 2008 and diagnosed with unilateral tympanic membrane perforation or myringosclerosis with contralateral intact ear based on otoscopic examination were included in the present study. Exclusion criteria were as follows: presence of cerumen, otorrhea or excessive hair in external auditory canal, an extremely narrow canal, evidence of infection, previous ear surgery or presence of ear pathology. In order to reduce the effects of variables such as age and gender, patients were allocated into matched groups. Patients receiving systemic medications, patients with a current infection that may cause fever or a body weight > 100 kg were also excluded.

Verbal consent was obtained from all patients. Measurements were done at constant room temperature (22±1°C) by the same physician using the same methods. Patients were not allowed to consume hot or cold beverages (e.g. coffee and tea) or smoke within 2 hours before the measurements and they were allowed to rest for 5 minutes just prior to the measurements. All measurements were done in supine position in order to reduce any effect of posture. Monoaural tympanic membrane perforation group patient is consisted of %20 large peforation (total) and 80% small perforation. Size of perforation are too immaterial to be clinically relevant. There fore, no emphasis. Simultaneous measurements were obtained from the two ears, axilla, mouth and nose.

Procedure

Auricle was pulled posteriorly and superiorly for better exposure of the canal. Then the probe of non-contact infrared tympanic thermometer was placed into the external auditory canal in the direction of the eye so that it will face tympanic membrane. For each measurement, the probe was kept in place until the triple beep sound. The average of two consecutive measurements were recorded and a fully calibrated infrared tympanic thermometer was used (Braun Thermoscan ® IRT 3520 Germany).

For the measurements of oral temperature, disposable tip of a regular digital thermometer (Omron Eco-Temp Digital Thermometer, Europa) was placed sublingually near frenulum and kept in place until acoustic signals. Patient was instructed to breathe through the nose and not to speak. The average of two consecutive measurements were recorded.

For axillary measurements, the most common type of mercury thermometer was used (mercury-in-glass thermometer). Before the measurement, axillary region was wiped with a dry towel and the thermometer was shaken to ensure that baseline reading was below 35.8 C°. The probe was placed to the upper part of axilla and the patient was instructed to hold the arm in adduction. The reading was recorded after 4 to 5 minutes.

Prior to nasal temperature measurements, the patient was instructed to breathe through the mouth and not to move. First, the probe (tip) of the infrared tympanic thermometer was placed into right nasal vestibule so that it will face inferior concha and kept in place until the triple beep sound. Two consecutive measurements were made and their average was recorded. Then the same procedures were repeated for the left nasal vestibule. Braun Thermoscan®IRT 3520 (Germany) infrared thermometer was used for the measurements.

Statistical analysis

Due to the absence of a dependent variable in the study, paired sample t test was used for the comparisons of two groups and ANOVA was used for the comparisons of more than two groups. Both groups had normal distribution and a

Table 1. Descriptive Statistical Data of Temperature Measurements for the Patients with Tympanic Membrane Perforation (n 44) and Tympanosclerosis (n 29)

Summary Statistics Table 1	N	Mean	95% CI	Variance	SD	RSD	SEM	Median	Minimum	Maximum
normal ear	44	37,034	36,919 - 37,149	0,1428	0,3778	0,0102	0,05696	37,100	36,300	37,800
perforated ear	44	37,048	36,961 - 37,134	0,08116	0,2849	0,00769	0,04295	37,100	36,400	37,500
axillary	44	36,700	36,554 - 36,846	0,2302	0,4798	0,01307	0,07234	36,800	35,600	37,500
oral	44	37,050	36,923 - 37,177	0,1733	0,4162	0,01123	0,06275	37,100	36,100	38,000
right nasal	44	32,850	32,321 - 33,379	3,0240	1,7390	0,05294	0,2622	33,400	29,700	35,500
left nasal	44	33,475	32,961 - 33,989	2,8549	1,6897	0,05048	0,2547	34,100	30,000	36,600
normal ear	29	37,117	37,003 - 37,231	0,09005	0,3001	0,008085	0,05572	37,100	36,600	37,600
tympanosclerosis	29	37,121	37,027 - 37,214	0,06027	0,2455	0,006614	0,04559	37,100	36,800	37,700
axillary	29	36,928	36,766 - 37,089	0,1799	0,4242	0,01149	0,07877	37,000	36,000	37,700
oral	29	37,183	37,058 - 37,307	0,1072	0,3274	0,008805	0,0608	37,200	36,400	37,900
right nasal	29	32,890	32,276 - 33,504	2,6052	1,6141	0,04908	0,2997	32,800	30,100	35,600
left nasal	29	33,062	32,362 - 33,762	3,3874	1,8405	0,05567	0,3418	33,300	30,100	36,300

p value <0.05 was considered significant (at 95% CI, for α=0.05 and 1-β=0.80). For the analysis of data, SPSS 16.0.1 for Windows and MedCalc®Turkey v10.0.1 software packages were used.

RESULTS

A total of 44 patients with perforation of tympanic membrane were included (22 male and 22 female, mean age: 32.5 ±12.8 years, age range: 10-62 y). On the other hand, the number of patients with myringosclerosis was 29 (15 male and 14 female, mean age: 33.5±12.4 years, age range: 13-65). The mean temperatures, minimum, maximum and median values at 95% CI, and standard deviation (SD), relative standard deviation (RSD) and median standard error (SEM) values of the two groups are shown in Table **1**. Among patients with monoaural perforation, similar temperature measurement results were obtained from the diseased and contralateral normal ear (P = 0.7780, SD± 0.3189) (Fig. **1**). The same relation was also true for the patients with monoaural myringosclerosis (P = 0.9346, SD± 0.2244). (Fig. **2**). Among patients with perforation (n=44), the mean temperature measured from the contralateral normal ear was similar to the oral temperature (P=1.000, SE± 0.0771); however, statistically significant differences was found between axillary temperature (p<0.014, SE± 0.094), right nasal temperature (p<0.0001, SE± 0.266) and left nasal temperature (p<0.0001, SE± 0.261) (Fig. **3**). On the other hand, among patients with myringosclerosis (n=29), the mean temperature measured from the contralateral normal ear was similar to the axillary (P=0.2841, SE± 0.0761) and oral temperature (P=1.0000, SE± 0.0706), whereas it significantly differed from right (p<0.0001, SE± 0.297) and left nasal temperature (p<0.0001, SE± 0.334) (Fig. **4**).

DISCUSSION

Over the past decade, ITT has increase wider acceptance. Nurses, parents and children have rated it higher in terms of rapidity, ease of use, cleanliness, safety and cost effectiveness [8]. This method of temperature measurement through ear offers advantages for both patients and nurses, including elimination of the needs for contacting mucous membranes and special handling procedures, which may be particularly important in terms of infection control [9]. The use of ITT for temperature measurements is step by step becoming more common in hospital settings, as this method allows users to quickly and non-invasively measure body temperature by inserting a directional probe into the ear canal. ITT offers a more comfortable and less stressful measurement. Infrared thermometers detect the infrared radiation emitted from the tympanic membrane and external auditory canal [10].

Several features of the external ear canal such as a narrow canal, presence of excessive hair or cerumen, presence of external otitis and canal wall down surgery invalidate the ITT measurements [11]. Presence of serous otitis media or inserted ventilation tube does not affect these measurements [12]. In the present study, ITT measurements were not affected by the presence of myringosclerosis or tympanic membrane perforation.

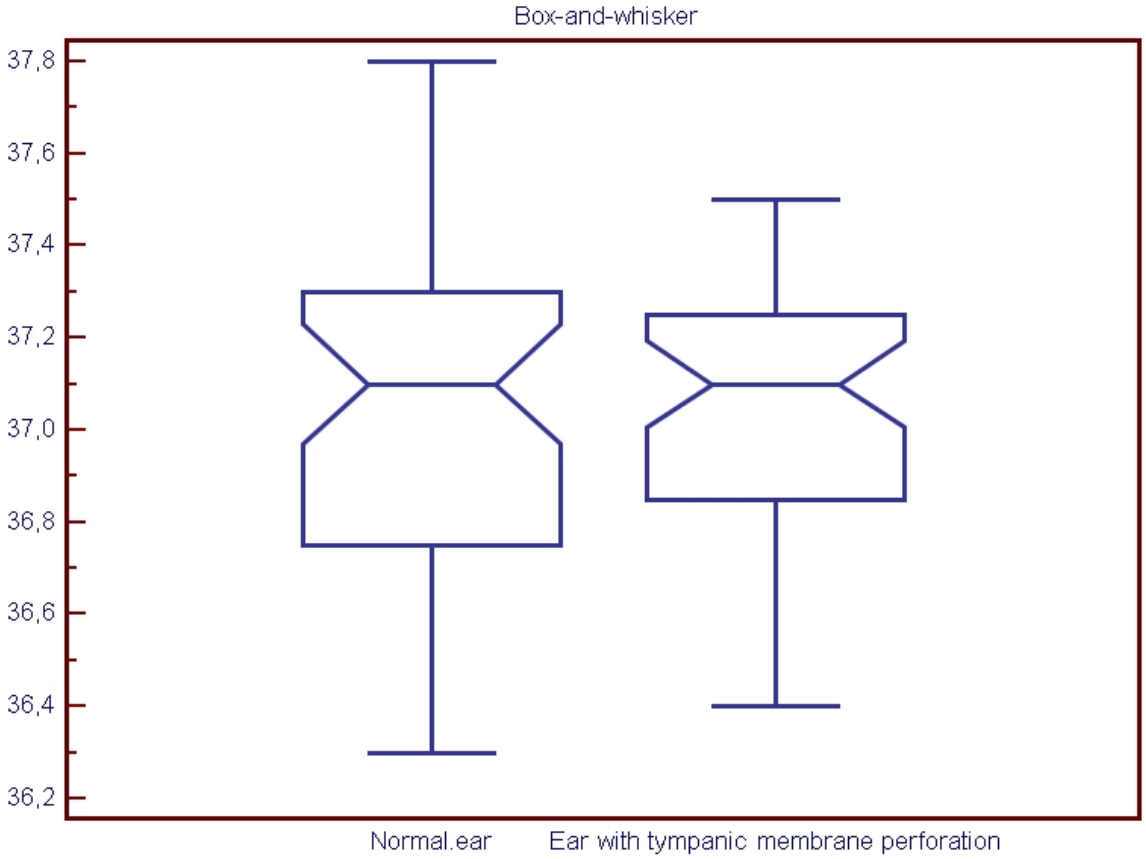

Fig. (1). Graphic representation of the measurements from the normal ear and from the ear with tympanic membrane perforation.

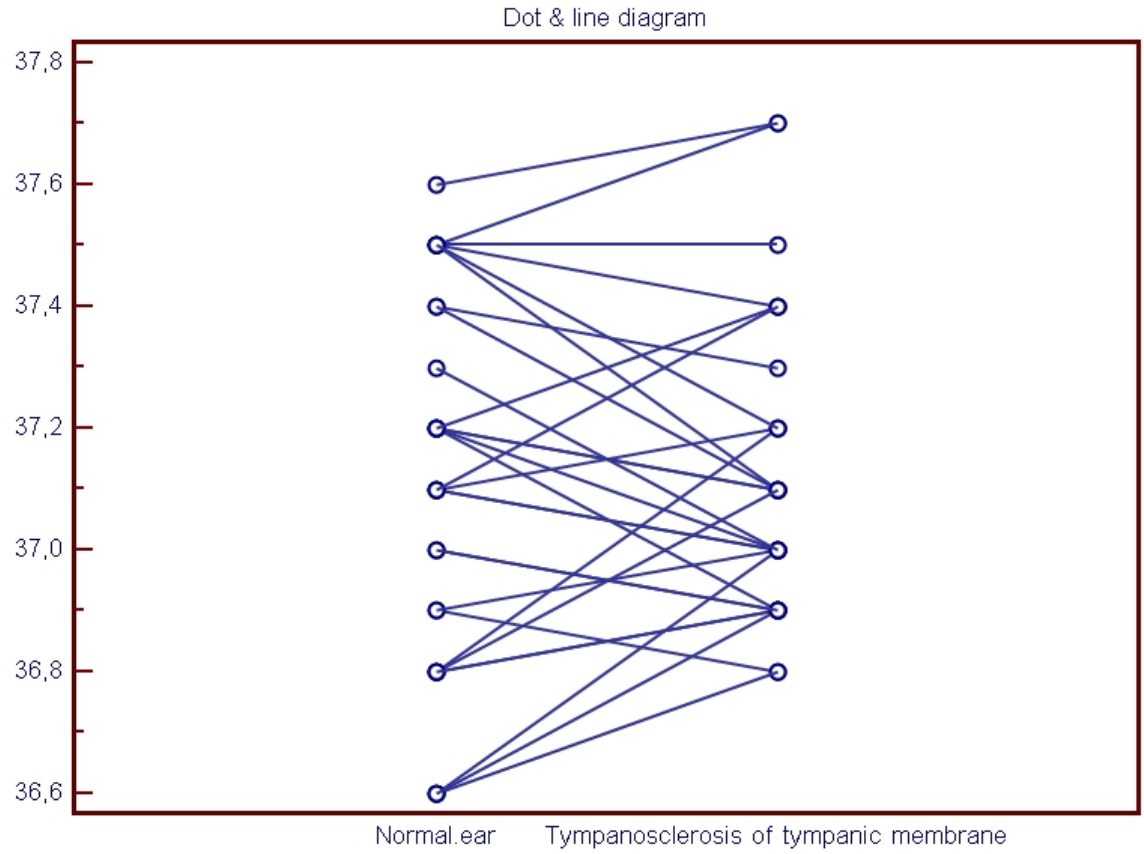

Fig. (2). Diagram of the data from the normal ear and from the ear with tympanosclerosis.

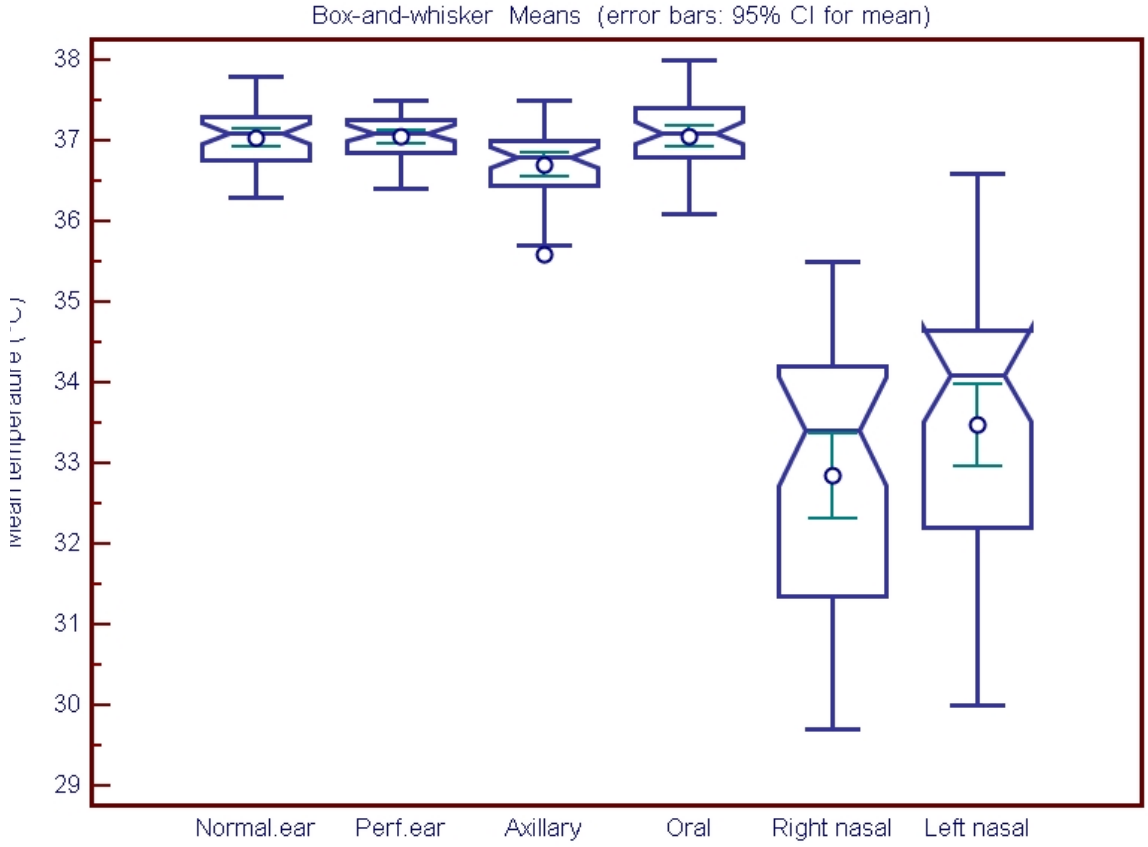

Fig. (3). Axillary, oral, right nasal and left nasal fever measurements with 95% confidence intervals in patients with unilateral perforation and normal contralateral ear.

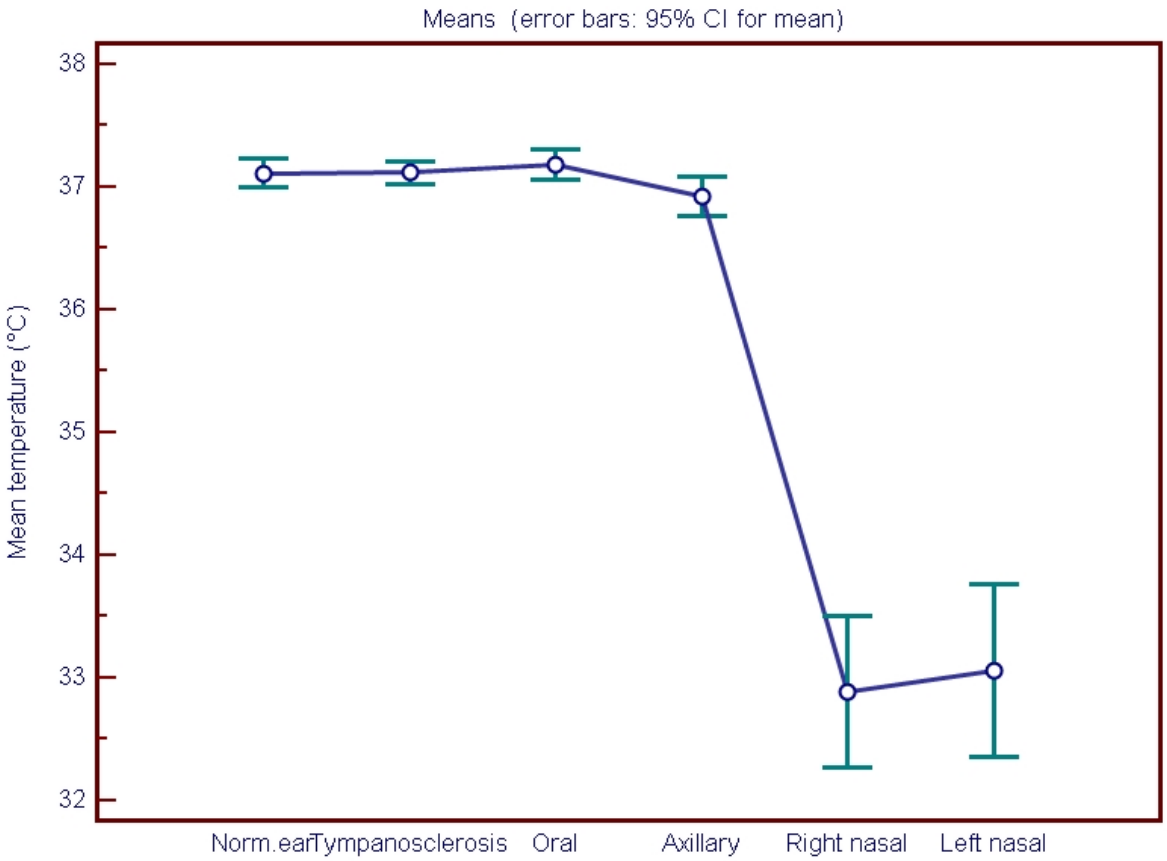

Fig. (4). Axillary, oral, right nasal and left nasal fever measurements with 95% confidence intervals in patients with unilateral tympanosclerosis and normal contralateral ears.

In intensive care units and emergency departments, temperature measurement is an essential component of patient assessment and management. An optimal temperature measurement device should be minimally invasive and should provide rapid results in a reliable, accurate and safe manner to support clinical decisions [13]. As noted in previous studies, axillary temperature measurements significantly underestimate core temperature when compared to aural and oral measurements.

The primary objective of the present study was to examine whether ITT measurement is an accurate and reliable indicator of core temperature in adults, when compared to oral, axillary and nasal measurements. We found a close agreement between ITT measurements and oral measurements, rather than axillary measurements.

In the study of Dodd SR *et al*. [13] infrared thermometers failed to measure accurately the temperatures of 3 out of 10 febrile children; and the authors concluded that ITT was not suitable for the measurement of body temperature. According to M Sund-Levander *et al*. [14] all measurements should be made from the same ear using the same device and method, and if possible, private devices should be used for each individual or otherwise hospital type of devices are recommended.

Many studies have been published examining the accuracy of ITT in comparison with core temperature measurement techniques [3,4,8,15]. Despite the heterogeneity of conclusions, ITT is still widely used in pediatric practices and in emergency rooms [4,8,9,16,17].

Occasionally the site for temperature measurement may need to be changed in response to the patient's condition. For example, in a patient with a recent need for oxygen administration, a switch from oral to tympanic measurements may be more suitable. Because, as a result of the difficulties with the correct positioning of the probe in the sublingual pocket, inaccurate readings may occur. A child endeavor against rectal temperature measurement may be better served if the nurse selects the axillary or tympanic sites [18].

Nasal mucosal temperature was measured in 71 healthy subjects with an electronic thermometer and no correlation was found between the nasal mucosal temperature and age or sex [19]. Using ITT, Willat DJ [20] measured significantly higher nasal temperature values during expirium compared to inspirium and temperature of the nasal mucosa was parallel to the atmospheric temperature. In the present study, nasal mucosa did not represent a suitable site for an accurate measurement of body temperature, which may be explained by the following: (i) it is a dynamic and an open space at its both ends and it is an erectile organ, (ii) it is involved both in inspirium and expirium, and (iii) compliance issues such as the need for holding the breathe during measurements.

SUMMARY

ITT measurements agreed more closely with core temperature than nasal and axillary measurements, in adults with perforation or myringosclerosis. ITT and oral

temperature measurements had minimal variability compared to axillary measurements. Right and left nasal temperature measurements were inaccurate and highly variable; and they did not agree with core temperature.

CONCLUSION

ITT is a reliable, non-invasive, practical and accurate method for the detection of fever in adults. ITT has gained the confidence of nurses for the measurement of this important vital sign. The recommended site of measurement should assure patient comfort and cooperation and it should be appropriate for the nurse; and this strategy provides better compliance for frequent fever measurements.

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