



Does central tympanic membrane perforation affect infrared tympanic thermometer measurements in adults?

Hamdi Tasli^{a,*}, Mert Cemal Gökgöz^{b,**}

^a Birecik State Hospital, Department of Otolaryngology, Head and Neck Surgery, Sanliurfa, Turkey

^b Siirt State Hospital, Department of Otolaryngology, Head and Neck Surgery, Sanliurfa, Turkey

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ABSTRACT

Objective: Infrared Tympanic Thermometer (ITT) is one of the most useful instruments for accurately measuring temperature. The effects of ear pathologies on ITT measurement remain unclear. The purpose of this study is to determine if tympanic membrane perforation (TMP) affects ITT measurements in adult patients.

Material and methods: A total of 90 adult patients with monaural central TMP were enrolled in this study. Patients were categorized into three subgroups according to perforation size (1–3 mm, 4–7 mm, and 8–10 mm). The tympanic temperatures of the affected and unaffected sites, and subgroups were compared with each other. **Results:** This study contained 54 (60%) males and 36 (40%) females ranging from 20 to 58 years of age (mean age: 30.74 ± 9.61 years). The mean tympanic temperature of the side affected with TMP was $36.340\text{C} \pm 0.610\text{C}$. The mean tympanic temperature of the unaffected side with healthy and intact tympanic membrane was $36.330\text{C} \pm 0.60\text{C}$. The Pearson correlation score for the tympanic temperatures and the size of TMP was 0.22 which was not significant ($r = -0.12$).

Conclusion: TMP and perforation size do not affect ITT measurements in adult patients.

1. Introduction

Accurate measurement of body temperature is crucial in clinical practice, especially for the diagnosis and treatment of disorders which alter thermoregulatory function (Onur et al., 2008). Many different types of thermometers exist: liquid-in-glass thermometers (mercury or spirit), thermistor-based electronic clinical thermometers, liquid crystal indicator-based thermometers, chemical thermometers, and infrared tympanic thermometers (ITT) (Ng et al., 2002). Unfortunately, all have disadvantages as well as advantages, and there is no universally recognized ideal thermometer.

The ITT can be used quickly and easily, is convenient for both the patient and health provider, decreases the risk of exposure to infectious diseases for health personnel during rectal temperature measurement, and is not influenced by factors known to spuriously affect oral temperature (Terndrup et al., 1989; Tandberg et al., 1983). It is also non-invasive and requires minimal cooperation from the patient (Alexander et al., 1991; Edge et al., 1993).

There is a limited number of studies investigating the effect of ear pathologies on ITT measurement in the literature (García Callejo et al.,

2004; Schmäler et al., 2006). The purpose of this study is to determine if tympanic membrane perforation (TMP) and perforation size affect ITT measurements in adult patients.

2. Material and methods

The study was carried out according to the tenets of the Declaration of Helsinki and was approved by the local review board prior to the study taking place. All data were collected prospectively from March to November 2017. A total of 90 adult patients with monaural central TMP were enrolled in this study after obtaining their written informed consent. Patients were categorized into three subgroups according to perforation size (1–3 mm, 4–7 mm, and 8–10 mm), and tympanic temperatures were compared with each other. Patients' contralateral tympanic membrane was healthy and intact, and affected and unaffected ears showed no signs of infection.

The measurements were done by a single physician in the same room which was kept at a constant temperature of 20C . All the patients rested for 1 min before the measurement was taken. ITT measurement was performed using a noncontact tympanic thermometer

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* Corresponding author. Birecik State Hospital, Department of Otolaryngology, Head and Neck Surgery, 63400, Birecik, Sanliurfa, Turkey.

** Corresponding author. Siirt State Hospital, Department of Otolaryngology, Head and Neck Surgery, Siirt, Turkey.

E-mail addresses: hamditasli@gmail.com (H. Tasli), drmcgokgoz@gmail.com (M.C. Gökgöz).

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Table 1The infrared tympanic thermometer (ITT) measurement, Paired *t*-test and Pearson correlations results of the affected, unaffected sides and subgroups.

| Tympanic Membrane with Central Perforation | | | | Healthy/Intact Tympanic Membrane | | | Paired <i>t</i> -test | | Pearson Correlations | |
|--|-----------|--------------|----------------|----------------------------------|-----------|----------------|-----------------------|------|----------------------|------|
| Size | n | Mean (°C) | Std. Dev. (°C) | n | Mean (°C) | Std. Dev. (°C) | Mean (°C) | p | r | p |
| 1-3 mm | 30 | 36,46 | 0,74 | 90 | 36,33 | 0,6 | 0,01 | 0.54 | -0,12 | 0.22 |
| 4-6 mm | 30 | 36,35 | 0,58 | | | | | | | |
| 7-9 mm | 30 | 36,22 | 0,47 | | | | | | | |
| Total | 90 | 36,34 | 0,61 | | | | | | | |

Std.Dev: Standard Deviation.

(Genius 2 Tympanic Thermometer; Covidien, Mansfield, USA.) set to core mode. A polyethylene tip was used to cover the tympanic thermometer probe. The probe was inserted into the external auditory canal after manipulating the pinna posteriorly with gentle traction. The measurements were performed twice for each ear at 2-min intervals. The first side was randomized, and all measurements were performed according to the user manual of the ITT device. The mean of the two measurements of each ear was calculated.

2.1. Inclusion/exclusion criteria

Only adult patients with monaural TMP were recruited. The exclusion criteria included the following: diagnosis of any acute or chronic infections of the external auditory canal, obliteration of the external auditory canal by cerumen or any benign or malign neoplasm, ear drainage, blood, cerebrospinal fluid, ear wax plugs, foreign bodies in the ear canal, history or clinical evidence of ear surgery, head and neck radiotherapy history, pregnancy, and illiteracy.

2.2. Statistical analyses

The results are presented as percentages, mean, standard deviation (SD) and the number (%) of patients. A paired *t*-test was used to compare both affected and unaffected ears. Analysis of variation (ANOVA) testing was used to compare multiple subgroups and the Bonferroni test was also used as a post hoc test. $P < 0.05$ was considered a significant difference for the results. The strength of the linear relationship between the tympanic perforation size and ITT results was measured by means of Pearson's correlation. Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS 17.0 for Windows; IBM, Armonk, NY, USA) software.

3. Results

This study contained 54 (60%) males and 36 (40%) females ranging from 20 to 58 years of age (mean age: 30.74 ± 9.61 years). The mean tympanic temperature of the side affected with TMP was 36.34 ± 0.61 °C. The mean tympanic temperature of the unaffected side with healthy and intact tympanic membrane was 36.33 ± 0.6 °C. There was no statistically significance difference between the affected and unaffected sides (mean difference 0.01 °C, $P: 0.54$) (Table 1).

The mean tympanic temperatures of each subgroup (perforation size of 1–3 mm, 4–7 mm, and 8–10 mm) were 36.46 ± 0.74 °C, 36.35 ± 0.58 °C, and 36.22 ± 0.47 °C, respectively. According to the ANOVA test, no difference was seen among the subgroups, and no statistical significance was found ($P: 0.32$).

The Pearson correlation score for the tympanic temperatures and the size of TMP was 0.22 which was not significant ($r = -0.12$). There was no correlation between the size of perforation and ITT measurements according to the Pearson correlation test ($P < 0.01$) (Table 1).

4. Discussion

Measurement of body temperature is one of the most common and most important clinical investigations, especially in the diagnosis of infectious diseases. It was recently shown that the ITT is one of the most useful instruments for accurately measuring temperature (Fraden et al., 1991). Body temperature is regulated by the hypothalamus. The ITT measures the radiant heat emitted from the tympanic membrane (Edge et al., 1993) by sharing the central carotid vascularization, which reflects the temperature of the hypothalamus (García Callejo et al., 2004). Its use is also quick, practical, and non-invasive, and it requires minimal cooperation from the patient (Alexander et al., 1991; Edge et al., 1993). Furthermore, non-suppurative otitis media, fluid in middle ear, ventilation tubes, and minor ear surgery do not affect ITT measurements (García Callejo et al., 2004; Schmäl et al., 2006).

Only two studies exist in the literature which have examined the effects of TMP on ITT measurements, and, surprisingly, only one of them was performed on adults. García Callejo et al. (2004) evaluated the influence of different otoscopic findings on ITT measurements. They evaluated 25 children with monaural TMP and found no significant differences between both ears. Their study also showed that acute otitis externa, cerumen, and previous major surgery decreased ITT measurements. It was concluded that TMP, otitis media, fluid in the middle ear, and ventilation tubes did not modify ITT measurements (García Callejo et al., 2004). Schmäl et al. (2006) investigated the effects of pathologic ear findings on ITT measurements. They evaluated 21 adult patients with monaural central TMP. They found that the mean difference was 0.58 °C and that there was no significant difference between the measurements of both ears. They concluded that minor ear surgery, scar formation, and TMP have no influence on the ITT measurements of both affected and unaffected ears (Schmäl et al., 2006). Similar to these results, this study showed that there were not any statistically significant differences between temperatures measured for both ears in patients with monaural TMP.

We also investigated whether the size of the perforation had an effect on the measurement of ITT; this has not yet been mentioned in the literature. We categorized affected ears with central perforations into three subgroups according to perforation size and compared them with the ITT measurements. There was no statistically significant difference among the ITT measurements of the three subgroups. Finally, there was no correlation between the size of perforation and ITT measurements, and this can be explained by tympanic blood supply and vessel anatomy. There are fewer blood vessels around the central part of the tympanic membrane and middle ear. The tympanic membrane and the middle ear are supplied by tympanic artery which is a branch of the internal maxillary artery, and originates from the external carotid; and also by internal auditory artery which is a branch of the anterior inferior cerebellar artery, originates from basilar artery. Even if the tympanic membrane is perforated, these arteries provide adequate infrared emission, and thus the body temperature is appropriately measured.

The major limitation of this study is the small number of the patients. In addition, only central perforations were evaluated in this study, and different types of TMP as marginal perforations can help to clarify the role of TMP on ITT measurement.

5. Conclusion

Central tympanic membrane perforation and perforation size do not affect ITT measurements in adult patients. In the future, studies comparing the tympanic temperatures of ears with different types of tympanic membrane perforations in addition to chronic non-suppurative and suppurative otitis media can augment these results, especially in adult patients.

Authors contributed

Each of the authors has contributed to, read and approved this manuscript.

Conflicts of interest

All authors declare that they have no conflict of interest.

Ethical approval

This manuscript is original and it, or any part of it, has not been previously published; nor is it under consideration for publication elsewhere.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.

Financial disclosure

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.joto.2018.09.001>.

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