Influence of Minor Ear Surgery on Infrared Tympanic Thermometry

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Background: Infrared tympanic thermometry (ITT) is often used for postoperative recovery room monitoring regardless of recent minor otologic surgery.

Objective: To evaluate the use of ITT in pediatric patients who have undergone bilateral myringotomy with insertion of pressure-equalizing tubes.

Design: A prospective cohort study.

Setting: Tertiary care academic medical center.

Patients: Consecutive patients of a staff pediatric otolaryngologist (M.A.R.): (1) ear surgery group, children aged 10 years or younger undergoing bilateral myringotomy with insertion of pressure-equalizing tubes and (2) non–ear surgery group, children aged 10 years or younger undergoing bilateral tonsillectomy with or without adenoidectomy.

Interventions: Immediate preprocedure temperature measurements included right and left ear ITT. Immediate postprocedure temperature measurements included right and left ear ITT and thermistor probe rectal temperature.

Main Outcome Measures: The average difference between the preprocedure and postprocedure tympanic temperature in the ear surgery group was compared with that in the non–ear surgery group. The average difference between postprocedure rectal and ear temperature in the ear surgery group was compared with that in the non–ear surgery group.

Results: There were 20 patients (40 ears) in the ear surgery group and 20 patients (40 ears) in the non–ear surgery group. In the ear surgery group, the average difference between the preprocedure and postprocedure tympanic temperature (0.55°C) was not significantly different from that (0.62°C) in the non–ear surgery group (P = .66, 1-way analysis of variance). In the ear surgery group, the average difference between postprocedural rectal and ear temperature (1.94°C) was not significantly different from that (1.89°C) in the non–ear surgery group (P = .76, 1-way analysis of variance).

Conclusion: Recent minor ear surgery (bilateral myringotomy with insertion of pressure-equalizing tubes) does not have a significant effect on ITT measurements in pediatric patients.


Temperature measurement is an integral part of medicine, and is used routinely in the ambulatory postoperative setting. During the past decade, noncontact infrared tympanic thermometry (ITT) has been added to the array of clinical techniques available for temperature measurement of pediatric patients. The popularity of ITT has been owing to the fact that this technique provides a temperature reading within seconds, is noninvasive, and is well accepted by children, parents, and nurses.1 Despite these advantages, the ability of ITT to assess patient temperature as accurately as other more traditional techniques is still actively debated.2-10

It has been the practice of the recovery room at our institution to use ITT routinely in the postoperative evaluation of pediatric patients who have undergone minor surgical procedures. This prospective cohort study evaluates the appropriateness of noncontact ITT in pediatric patients who have undergone bilateral myringotomy with insertion of pressure-equalizing tubes for the treatment of otitis media related to eustachian tube dysfunction.

RESULTS

DEMOGRAPHIC DATA

Twenty consecutive patients (40 ears) were enrolled in the ear surgery group, and 20...
**PATIENTS AND METHODS**

The study population consisted of patients aged 10 years or younger who were undergoing minor otolaryngologic surgical procedures. All patients were seen in clinics at Mount Sinai Hospital, New York, NY, under the direction of a single pediatric otolaryngology attending physician (M.A.R.). No study exclusions were made based on patient sex or ethnic origin. Standard clinical indications for surgery were used. Patients with congenital or acquired anatomic anomalies of the external and/or middle ear that could potentially interfere with ITT measurements were excluded. Patients with otitis externa were excluded, as were those who required application of topical otic preparations (which is not routine at our institution after bilateral myringotomy with ventilation tube placement).

Approval by the institutional review board at Mount Sinai School of Medicine was obtained before initiation of the study, and informed consent by the parent or legal guardian was obtained before each subject's enrollment in the study.

Two groups of pediatric surgical patients were studied in a prospective fashion. The first group consisted of 20 consecutive patients with eustachian tube dysfunction who were undergoing bilateral myringotomy with placement of pressure-equalizing tubes (the “ear surgery” group). The second group consisted of 20 consecutive patients with chronic tonsillitis and/or sleep-disordered breathing who were undergoing bilateral palatine tonsillectomy with or without adenoidectomy (the “non–ear surgery” group). The following data were obtained for each patient: age, sex, underlying medical conditions, current medications, and history of previous myringotomy. Patients undergoing simultaneous ear surgery and tonsillectomy with or without adenoidectomy were excluded.

All operations were performed in their routine manner, by or under the supervision of the same attending surgeon (M.A.R.). Myringotomy and tube placement was performed using an operating microscope and a metal ear speculum. Inhalational halogenated fluorane anesthesia was administered via face mask. Under operative microscopy, cerumen, if present, was cleared from the right external auditory canal, and the tympanic membrane was visualized in its entirety. A myringotomy blade was used to make a radial incision in the anteroinferior quadrant of the tympanic membrane. Auris media fluid, if present, was aspirated with a No. 5 otologic suction device. Then, a pressure-equalizing grommet (Shepard fluoroplastic grommet with wire, 1-mm inner diameter; Smith & Nephew Inc, Memphis, Tenn) was inserted with an alligator forceps and, if necessary, a Rosen pick. The same procedure was then performed in the patient's left ear.

In the non–ear surgery group, each patient was orotracheally intubated and inhalational halogenated fluorane anesthesia was administered by an anesthesiologist. Under operative microscopy, cerumen, if present, was cleared from the right and the left external auditory canals, and the right and left tympanic membranes were visualized in their entirety. The tonsils were then removed in the usual manner using Bovie electrocautery. The adenoids were examined indirectly with a dental mirror and, if indicated, were removed using an adenoid curet. Hemostasis was achieved using suction electrocautery.

Noncontact ITT measurements were taken at the following times: (1) preoperatively (immediately after induction of general anesthesia [and after intubation in the non–ear surgery group], but before the start of the otolaryngologic procedure) and (2) postoperatively (immediately after completion of the otolaryngologic procedure, but before awakening the patient from general anesthesia). For preoperative and postoperative ITT, measurements were performed twice in the right ear and twice in the left ear, such that for every measurement, there was a first sample and a second sample (repeated measures).

Infrared tympanic thermometry was performed using a noncontact infrared tympanic thermometer (First-Temp Genius model 3000A; Intelligent Medical Systems, Carlsbad, Calif), set to core mode. The tympanic thermometer probe was covered with a new polyethylene tip for each patient, and was inserted into the external auditory canal with gentle posterior traction on the pinna. The probe was aimed in the direction of the tympanic membrane, in the same manner as an otoscope. The scan button was depressed, and the liquid crystal temperature display was recorded. The tympanic thermometer was calibrated at the commencement of the study by the Mount Sinai Hospital Biomedical Engineering Department using a manufacturer-supplied “black box.”

Immediately after the completion of the surgical procedure, but before awakening the patient from general anesthesia (while the postoperative ITT measurements were being recorded), a rigid rectal thermistor probe (Filac F-1010 Electronic Thermometer; Sherwood Medical, St Louis, Mo) was inserted into the patient’s rectum to a distance of 5 cm. The probe remained in place long enough for the temperature display to record a final reading (approximately 90

consecutive patients (40 ears) were enrolled in the non–ear surgery group. The mean patient age was 46.3 months (range, 8-109 months) for the ear surgery group and 73.8 months (range, 24-121 months) for the non–ear surgery group. The difference in mean age between the groups was statistically significant ($P = .008$, independent-sample $t$ test). The male-female ratio was 18:2 in the ear surgery group and 9:11 in the non–ear surgery group.

In the non–ear surgery group, the preoperative diagnosis was sleep-disordered breathing in 14 patients and chronic tonsillitis in 6 patients. Tonsillectomy and adenoidectomy were performed in 17 patients in the non–ear surgery group, while the remaining 3 patients in this group underwent tonsillectomy only.

Significant medical history in the ear surgery group included 2 patients with asthma and 1 with bronchiolitis. In the non–ear surgery group, significant medical history included 1 patient with α-thalassemia and 3 with asthma. Only 4 patients in the ear surgery group were taking medications at the time of surgery. These included albuterol sulfate home nebulizers for asthma (1 patient) and oral antibiotics for recent acute otitis media (3 patients). In the non–ear surgery group, only 2 patients were taking medications at the time of surgery. These included albuterol, cromolyn sodium, and fluticasone propionate inhalers for asthma (1 patient) and oral antibiotics for recent pharyngitis (1 patient). No patient was febrile at the time of surgery.
seconds). The rectal thermistor was calibrated at the commencement of the study by the Mount Sinai Hospital Biomedical Engineering Department.

STATISTICAL ANALYSIS

The statistics program used was Statistical Product and Service Solutions 10.0 for Windows (SPSS Inc, Chicago, Ill).

For all 40 patients enrolled in the study, the mean temperature for all first-sample measurements was compared with the mean temperature for all second-sample measurements, and the mean temperature for all right ear measurements was compared with the mean temperature for all left ear measurements. These and all subsequent comparisons were performed using a 1-way analysis of variance (ANOVA) with a 2-sided a level of .05 for statistical significance. As no difference was found between first- and second-sample measurements (as reported in the "Right vs Left and First- vs Second-Sample Measurements" subsection of the "Results" section), only the first ITT measurement in each ear was used for all subsequent analyses.

Main Outcome Measure 1

The following null hypothesis was tested: the performance of myringotomy with the insertion of a ventilation tube into the tympanic membrane will have no effect on the relationship between preoperative and postoperative ITT temperatures.

In the ear surgery group, the mean preoperative tympanic temperature (40 measurements, 20 each for the right and left ears) was compared with the mean postoperative tympanic temperature (40 measurements, 20 each for the right and left ears). An identical analysis was performed to detect any difference between preoperative and postoperative ITT temperatures in the non–ear surgery group.

For each patient, the difference between preoperative and postoperative ITT measurements (Δpre-post) was calculated by subtracting the postoperative from the preoperative ITT temperature. (There were 2 Δpre-post values for each patient, 1 each for the right and left ears.) Then, to detect differences between the ear surgery and the non–ear surgery groups, the mean Δpre-post in the ear surgery group was compared with the mean Δpre-post in the non–ear surgery group.

Main Outcome Measure 2

The following null hypothesis was tested: the performance of myringotomy with the insertion of a ventilation tube into the tympanic membrane will have no effect on the relationship between postoperative ITT and rectal temperature measurements.

STATISTICAL POWER

For each of the 2 main outcome measures previously described, the total number of subjects required for a 2-tailed test with a .05 significance level and a power of 80% was calculated using the following formula: $n_1=n_2=16\sigma^2/\delta^2$, where $n_i$ is the number of measurements in the ear surgery group; $n_i$ is the number of measurements in the control group; $\sigma^2$, an estimate of the SD, which equals $[(SD_{ear\ surgery\ group})^2+(SD_{control\ group})^2]/2$; and $\delta$, the maximal acceptable temperature difference between the ear surgery group and the non–ear surgery group, which was chosen to be 0.5°C for both main outcome measures. The value of 0.5°C for significant temperature change was chosen based on the fact that the same value was used in a similar statistical power analysis by Tomkinson et al in another published study that has investigated the effect of myringotomy tubes on ITT.

Using the SDs for the mean Δpre-post in the ear surgery and non–ear surgery groups, it was determined that 31 measurements in each group (ie, a minimum of 16 subjects in each group) would be necessary to achieve a 5% significance level for a 2-tailed test with a power of 80%.

Main Outcome Measure 2

Using the SDs for the mean Δrectal−ear in the ear surgery and non–ear surgery groups, it was determined that 38 measurements in each group (ie, 19 subjects in each group) would be necessary to achieve a 5% significance level for a 2-tailed test with a power of 80%.

In the ear surgery group, 4 patients had undergone a single bilateral myringotomy and tube placement operation in the past. At the time of the present study, the original ventilation tubes in these 4 patients were no longer in place, and the tympanic membranes had healed without perforations. No patients in the non–ear surgery group had undergone prior myringotomy procedures.

RIGHT VS LEFT AND FIRST- VS SECOND-SAMPLE MEASUREMENTS

The mean temperature for all right ITT measurements (35.46°C; SD, 0.65°C) was compared with the mean temperature for all left ITT measurements (35.41°C; SD, 0.73°C), and no difference was found ($P=.52$, 1-way ANOVA). In addition, when the mean temperature for all first-sample ITT measurements (35.49°C; SD, 0.66°C) was compared with the mean temperature for all second-sample ITT measurements (35.38°C; SD, 0.71°C), no difference was found ($P=.14$, 1-way ANOVA). For all further analyses, only the first ITT measurement in each ear was used.

MAIN OUTCOME MEASURE 1

For the 20 subjects (40 ears) in the ear surgery group, the mean preoperative ITT temperature (35.73°C; SD, 0.56°C) was significantly higher than the mean postop-
erative ITT temperature (35.18°C; SD, 0.69°C) \((P<.001, 1\text{-way ANOVA})\). Overall, the postoperative ITT temperature was lower than the preoperative ITT temperature in 29 of 40 paired measurements (Figure 1).

For the 20 subjects (40 ears) in the non–ear surgery group, the mean preoperative ITT temperature (35.84°C; SD, 0.52°C) was significantly higher than the mean postoperative ITT temperature (35.22°C; SD, 0.61°C) \((P<.001, 1\text{-way ANOVA})\). Overall, the postoperative ITT temperature was lower than the preoperative ITT temperature in 36 of 40 paired measurements (Figure 2).

The \(\Delta_{\text{pre-post}}\) was then calculated for each ear in each patient, and the mean \(\Delta_{\text{pre-post}}\) in the ear surgery group (0.55°C; SD, 0.71°C) was compared with the mean \(\Delta_{\text{pre-post}}\) in the non–ear surgery group (0.62°C; SD, 0.68°C) (Figure 3); no difference was found \((P=.66, 1\text{-way ANOVA})\).

**MAIN OUTCOME MEASURE 2**

The \(\Delta_{\text{rectal-ear}}\) was calculated for each patient (2 \(\Delta_{\text{rectal-ear}}\) values for each patient, 1 each for the right and left ears). The mean \(\Delta_{\text{rectal-ear}}\) in the ear surgery group (1.94°C; SD, 0.78°C) was then compared with the mean \(\Delta_{\text{rectal-ear}}\) in the non–ear surgery group (1.89°C; SD, 0.77°C) (Figure 4), and no significant difference was found \((P=.76, 1\text{-way ANOVA})\).

Postoperative rectal temperatures were invariably higher than postoperative ITT temperatures in all subjects. For patients in the ear surgery group, postoperative rectal temperatures were between 0.1°C and 3.3°C (mean, 1.94°C) higher than postoperative ITT temperatures. For patients in the non–ear surgery group, postoperative rectal temperatures were between 0.5°C and 3.7°C (mean, 1.89°C) higher than postoperative ITT temperatures.

**COMMENT**

In the present study, noncontact ITT readings were shown to be unaffected by the performance of bilateral...
myringotomy with ventilation tube placement in pediatric patients. The placement of a ventilation tube in the tympanic membrane had no significant effect on (1) the relationship between preoperative and postoperative ITT measurements and (2) the relationship between simultaneous postoperative ITT and rectal temperature measurements. The fact that the null hypotheses of the study were proved supports continued use of ITT as a routine method of postoperative temperature assessment in children undergoing myringotomy tube placement.

During the past decade, ITT has been added to the array of techniques available for clinical temperature measurement. The goal of any method of clinical temperature assessment is to determine core body temperature as accurately as possible. True core body temperature is found at the hypothalamus, a clinically inaccessible site. The pulmonary artery is considered to be the most accurate measurable site for assessing core temperature, but this type of measurement is only practical in specialized critical care situations. In young children in ambulatory care and home settings, it has been argued that rectal temperature is the most reliable technique for clinical temperature assessment. However, this technique may upset young children, requires clothing removal, and carries with it the remote risk of rectal perforation. Axillary temperature, while easily accessible, provides less accurate readings than rectal temperature measurements, and has low sensitivity for the detection of fever. Oral temperature measurements, while convenient and less invasive than rectal temperature measurements, are not practical in infants and many young children, and may demonstrate poor reliability in patients who have recently ingested hot or cold liquids.

Infrared tympanic thermometry has become increasingly popular since its commercial introduction. This technique provides a temperature reading within seconds, is easy to use, requires no clothing removal and no direct mucous membrane contact, and is well accepted by children, parents, and nurses. The tympanic thermometer works by identifying infrared emissions generated by the tympanic membrane as a function of temperature. It has been hypothesized that the temperature of the tympanic membrane, due to its proximity to the blood supply of the hypothalamus, may reflect true core body temperature. In critical care and intraoperative settings, ITT has performed well when compared with other more invasive techniques of core body temperature measurement in children, including direct-contact tympanic membrane thermometry.

The ability of noncontact ITT to accurately measure core body temperature in the pediatric outpatient setting has been debated in the literature. Infrared tympanic thermometry measurements have been described as reliable for clinical use in various pediatric age groups, with a sensitivity for fever detection as high as 100% in a pediatric emergency department. However, several studies have found ITT to be inaccurate, with unacceptably low levels of sensitivity for fever detection, and have recommended against its routine use in a pediatric outpatient setting. The present study was not designed to assess the sensitivity of ITT for the detection of fever.

The presence of otitis media does not appear to have any significant effect on the agreement between ITT and standard rectal measurements in pediatric patients. In addition, several investigators have found no difference between ITT temperature readings of infected ears when compared with uninfected ears in the same patient. No differences have been found for mean ITT temperatures between right and left ears in pediatric patients in general, and this finding is also supported by the present study. In addition, the presence of cerumen in the external auditory canal does not appear to affect ITT readings.

In the present study, for most subjects in the ear surgery and the non–ear surgery groups, postoperative ITT measurements were significantly lower than preoperative ITT measurements. This cooling effect was most likely due to the routine use of the inhalational general anesthetic agents isoﬂurane and sevoﬂurane in the study patients. These agents are well known to decrease core body temperature during an operation due to anesthetic-induced impairment of physiologic thermoregulatory control.

The effect of minor pediatric ear surgery on ITT measurements has been infrequently studied. In a 1991 report by Pransky, ITT and standard electronic oral thermometry were performed on 100 pediatric outpatients undergoing routine otolaryngologic office assessments for various conditions. Myringotomy tubes, which were present in some of the patients, reportedly did not affect ITT accuracy. In a 1996 study by Tomkinson et al, 21 children with otitis media (mean age, 5.3 years) underwent bilateral ITT preoperatively and postoperatively, and these readings were shown to be unaffected by the removal of middle ear fluid and the placement of a pressure-equalizing grommet. This study failed to include a distant temperature reference site for comparison with ITT measurements.

In the present study, ear surgery patients were younger when compared with non–ear surgery patients (see the “Demographic Data” subsection of the “Results” section). Since the average age for pressure-equalizing tube placement is often lower than that for adenotonsillectomy, the decision was made not to use age-matched cohorts, as this would skew the population away from the typical patient profile.

The sex imbalance in the ear surgery group that was noted in the present study was believed to be an anomaly resulting from the relatively small sample size, since this male preponderance is not replicated in large studies of eustachian tube dysfunction and standard surgical criteria were used in the present study for patient selection.

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