



## A COMPARATIVE STUDY OF TYMPANIC AND ORAL TEMPERATURES IN HEALTHY ADULTS<sup>1</sup>

### *ESTUDO COMPARATIVO DAS TEMPERATURAS TÍMPÂNICA E ORAL EM ADULTOS*

Milva Maria Figueiredo De MARTINO<sup>2</sup>

Ana Leda Bertoncini SIMÕES<sup>3</sup>

#### **A B S T R A C T**

##### **Introduction**

Physiological body signs are precious health indicators and it is up to the nursing staff to correctly measure signs such as tympanic temperature and have them registered on patient records. The tympanic thermometer is a successful example of the recent evolution in measuring equipment for emergency medicine, as it registers infrared radiation in the exterior auditory canal converting this information to core body temperature. It is a painless and adequate method to assist in diagnostic assessment and also to indicate the clinical condition of the patient, being widely utilized in diagnostic centers worldwide.

##### **Objectives**

The main objective of this study was to analyze and compare oral and tympanic temperature measurements, detect possible differences and describe the adequate

<sup>1</sup> Projeto financiado pela FAPESP. Processo nº 01/4865-5.

<sup>2</sup> Departamento de Enfermagem, Faculdade de Ciências Médicas, Universidade Estadual de Campinas. Cidade Universitária Zeferino Vaz, 13081-970, Campinas, SP, Brasil. Correspondência para/Correspondence to: M.M.F. MARTINO. E-mail: milva@obelix.unicamp.br

<sup>3</sup> Mestranda, Pós-Graduação em Enfermagem, Faculdade de Ciências Médicas, Universidade Estadual de Campinas.

technique for using the infrared digital thermometer to measure the tympanic temperature.

### Methods

Temperatures were measured in 103 patients from medical and surgical clinics of the Teaching Hospital of the Universidade Estadual de Campinas, Brazil, always at 10:00 a.m., for a three-month period. An assessment of the auditory canal and oral cavity was made and temperature measured whenever impediments were absent. Both types of thermometers were cleaned with 70% alcohol after each measurement and left to dry for five minutes, a fundamental hygienic precaution in the case of the tympanic thermometer to avoid errors when measuring temperature. The tympanic temperature was measured by means of an infrared sensor placed at 8.5-10mm depth in the region of the tympanic membrane utilizing two angles – anterior and posterior. In the case of oral temperature, intake of food or drink was not permitted and patients were not allowed to smoke for at least thirty minutes before having their temperature measured. The variation between the measurements obtained with oral and infrared digital thermometers, the influence of right and left canal variation and comparisons between temperature measurements were analyzed. The subjects were under ambulatory control but did not present alterations in body temperature or clinical symptoms at the time of temperature readings.

### Results

The results demonstrated no significant difference between the tympanic temperature measurements in each auditory canal and oral temperatures. Only the tympanic temperature measured at the anterior and posterior angle of each auditory canal presented a statistically significant difference ( $p=0.001$  - Wilcoxon test).

### Conclusions

1) The tympanic and oral temperatures presented no statistical differences. 2) The values of the tympanic temperature demonstrated a difference related only to the angle of measurement and not to the right or left side.

**Index terms:** tympanic temperature, infrared digital thermometer, measuring technique.

## RESUMO

### Introdução

*O termômetro timpânico é um exemplo de sucesso da recente revolução em equipamentos de medidas para a medicina de emergência, registra radiação aferida do canal auditivo que converte estas informações para dentro da temperatura corporal, sendo um método indolor e adequado para estas medidas, no momento sendo bastante utilizado em outros centros diagnósticos no mundo.*

### **Objetivo**

*O objetivo principal deste estudo foi analisar e comparar as medidas de temperatura timpânica e oral. Foram utilizados termômetros digitais auriculares e orais. As medidas foram efetuadas no horário das 10 horas a.m durante três meses, num total de 103 pacientes internados na clínica médica e cirúrgica do Hospital de Clínicas da Universidade Estadual de Campinas, Unicamp, Brasil.*

### **Métodos**

*Os sujeitos foram orientados a não ingerir alimentos quentes ou frios e não fumar, pelo menos trinta minutos antes da medida da temperatura oral. Para as medidas da temperatura timpânica utilizamos um instrumento auricular cuja profundidade foi de 8,5 a 10mm na região da membrana timpânica, em duas angulações, anterior e posterior. Para mensuração de ambas, os pacientes não podiam apresentar sinais e sintomas de infecção e nem apresentar temperaturas elevadas anteriormente à data da coleta.*

### **Resultados**

*Os resultados demonstraram que não houve diferença significativa entre as medidas da temperatura timpânica de cada canal auditivo e a temperatura oral. Somente a medida da temperatura timpânica no ângulo anterior e posterior de cada canal auditivo apresentou diferença significativa (teste Wilcoxon,  $p=0,001$ ).*

### **Conclusão**

*1) Não houve diferença significativa entre a temperatura timpânica e temperatura oral. 2) Os valores demonstrados para a temperatura timpânica somente em relação as medidas de ângulo mostraram diferenças significativas (teste Wilcoxon,  $p=0,001$ ) e não para as medidas dos canais direito e esquerdo.*

**Termos de indexação:** *temperatura timpânica, temperatura oral, técnica de medida.*

## **INTRODUCTION**

Body temperature is a physiological sign that demonstrates the balance between heat produced by the body and heat lost to the ambient. The individual body temperature may suffer variations caused by emotional alterations, influence of ambient temperature, physical activity, inadequate clothes, pathological processes and circadian rhythm. Normal body temperature values generally do not vary by more than one degree Centigrade in different people<sup>1</sup>. Body temperature measurements may be oral, rectal, axillary and tympanic, and the first and the last methods were used in this study.

In a hospitalized patient, temperature is a fundamental physiological sign and when altered it mainly indicates an infectious process. Nonetheless, an individual's body temperature may suffer variations caused by pathological processes and circadian rhythms, with temperatures in the morning being lower than at night and oscillating during the day<sup>2</sup>.

Therefore, climatic alterations and emotional excitation stimulate the sympathetic system and cause a rise in temperature. The temperature may rise two or three degrees with light exercise but when the exercise comes to an end, the body temperature returns to normal.

Tympanic membrane temperature is the best method for body temperature reading when compared with rectal or esophageal alternatives<sup>3-5</sup>.

A thermostat placed close to this membrane reflects cerebral temperature because of the pre-optical hypothalamus area. Since this region is well vascularized, it indicates core temperature values. This study compared oral and tympanic temperatures and the results showed that tympanic values were higher by 2.6 degrees centigrade. The difference was smaller in men exposed to the cold<sup>6</sup>.

The tympanic thermometer has been indicated in various studies as a non-invasive, non-painful, convenient, quick and easy method for checking body temperatures<sup>3</sup>. Temperature readings may be affected by factors such as otitis media, wax obstruction in the auditory canal, abnormal light reflection, edema of the tympanic membrane and erroneous technique without proper sealing, which allows the ambient temperature to affect the results<sup>7</sup>.

The tympanic thermometer is a successful example of the recent revolution in measuring equipment to be used in emergency medicine, as it registers radiation in the auditory canal and converts this information into body temperature. At present, it is widely utilized in diagnostic centers worldwide since it is a non-painful and adequate method for obtaining these measurements.

Other research studies evaluating this new technique<sup>4-6</sup> in children with burns concluded that the recorded tympanic temperature data of these patients assured enhanced patient care by reason of their acceptability, the short time needed to take these measurements, unaltered measured values and also because they help to precociously recognize and treat complications such as sepsis, pulmonary dysfunctions and others.

The purpose of this study was to verify the difference between the measurements obtained with the digital oral and infrared tympanic thermometers.

## PACIENTS AND METHODS

There were 103 participants in this study, all of them inpatients at the Cardiology Ambulatory Unit, Teaching Hospital (HC), *Universidade Estadual de Campinas* (Unicamp). Data collection began after receiving approval and authorization from the Nursing Service and the Research Ethics Committee of the Medical Sciences School, Unicamp. The patients signed terms of informed consent regarding their voluntary participation in the study, which involved measurement of their tympanic and oral temperatures.

The criteria for inclusion usually depended on the individual's general good health, absence of infection and absence of hyperthermia on the data collection day and the previous day.

Four digital thermometers were utilized, two of which were OMRON-MC 505 model and two oral More Fitness thermometers-MF-102 model, both having 0.1°C precision.

The most important stage in experimental studies is the calibration of instruments to be used in measuring the response variable. Calibration means comparing a measuring system with a similar system or with a better standard, and the standard is a reference value or the most accurate value. Calibration helps to determine how measurements obtained by means of a device differ from the standard measurement.

The thermometers were calibrated at the College of Mechanical Engineering, Unicamp, under the supervision of Prof. Dr. Kamal A.R. Ismail, in accordance with adequate procedures and their fundamental principles.

## Procedures

Careful measurements were taken while collecting data so that systematic errors could be eliminated and greater precision ensured<sup>8</sup>. The subjects first underwent an assessment of the auditory canal and the oral cavity. Measurements were taken

when there were no impediments. Both types of thermometers were cleaned with 70% alcohol before and after each reading, leaving the instruments to dry for five minutes. In the case of the tympanic thermometers, this hygiene precaution was important to avoid errors when taking the readings, while in the case of oral thermometer readings the intake of hot or cold food and drink was not permitted for at least thirty minutes before taking the readings.

The techniques used in taking the oral temperature (TO) readings followed those found in literature<sup>9,10</sup>, with the recommendation that thermometers be placed in the lateral sublingual space and the mouth kept closed until the instrument beeped, which was the required time for recording the reading, while the tympanic thermometer should be introduced to a depth of 8.5 to 10mm in the auditory canal.

The detailed procedure for taking the tympanic temperature (TT) included: 1) an explanation of the procedure to the subject; 2) delicate introduction of the probe into the auditory canal; 3) to fit the probe into the canal; 4) to stretch the ear upwards and backwards; 5) to switch on the thermometer and wait for the beep. This procedure was followed for two positions of the thermometer in the auditory canal: anterior (TTA) and posterior (TTP).

When taking the readings, the patients were advised to take a comfortable position.

The oral and tympanic temperatures were noted and later recorded on an Excel software table.

The Wilcoxon Rank Sum test was utilized for a comparative analysis of the two parameters and the significance level considered was  $p = 5\%$ .

## RESULTS AND DISCUSSION

The results demonstrated that the age of the individuals ranged from 21 to 85 years old (mean 55.19 years). There were 54 individuals of the female sex and 49 of the male sex.

The Wilcoxon statistical test was used to compare the two methods of obtaining temperature and showed that although the S.D. of the tympanic thermometer in the four readings was always greater than the S.D. of the oral thermometer, the difference between the two readings was not statistically significant (Table 1).

This result proved that the tympanic thermometer may be used without loss of information quality in cases where the use of the oral thermometer is restricted.

Prior training of technical personnel is needed to implement this method in routine hospital services. The results of this study should be made known, describing the carefulness required by this technique with regard to checking for earwax and anatomical malformation of the auditory canal.

It is important to underscore the fact that our results oppose those obtained in a study described in literature<sup>11</sup>, which showed that tympanic thermometer readings differed significantly from those of the oral thermometer.

**Table 1.** Oral and tympanic temperatures of the right and left ear/anterior and posterior angles (°C).

	n	Mean	SD	Maxi	Median	Min
TO	103	36.64	0.35	37.3	36.7	35.7
TTAR	102	36.29	0.46	37.2	36.4	35.1
TTPR	101	36.03	0.53	37.0	36.1	35.0
TTAL	85	36.25	0.51	37.2	36.3	35.1
TTPL	84	35.99	0.49	36.9	36.0	35.0

*p*-value = 0.001 (Wilcoxon test); SD = standard deviation; TT = tympanic temperature; TO = oral temperature TTAR = ear anterior right; TTPR = ear posterior right; TTAL = ear anterior left; TTPL = ear posterior left.

**Table 2.** Tympanic temperatures at anterior angle position (right ear; left ear) 0°C.

	n	Mean	SD	Maxi	Median	Min
TTAR	84	36.29	0.46	35.1	36.4	37.2
TTAL	84	36.25	0.51	35.1	36.3	37.2

*p*-value = 0.8847 (Wilcoxon test); TTAR = ear anterior right; TTAL = ear anterior left.

**Table 3.** Tympanic temperatures at posterior angle position (right ear; left ear) 0°C.

	n	Mean	SD	Maxi	Median	Min
TTPR	82	36.03	0.52	35.0	36.1	37.0
TTPL	82	35.99	0.49	35.0	36.0	36.9

*p*-value = 0.5662 (Wilcoxon test); TTPR = ear posterior right; TTPL = ear posterior left.

The second analysis that compared the measurement of tympanic temperatures, shown in Tables 2 and 3, demonstrated that the position of the thermometer while taking the tympanic temperature has significant influence on the readings (Wilcoxon test  $p \geq 0.005$ ). This influence is confirmed by the results obtained in previous studies<sup>10</sup>, where the position of insertion in the auditory canal altered the value of the readings.

## CONCLUSION

The results of this study should be divulged along with the carefulness required in this technique in relation to checking for earwax and anatomical malformation of the auditory canal.

This result proved that the tympanic thermometer could be used without loss of information quality in cases where the use of the oral thermometer is restricted.

Prior training of technical personnel is needed to implement this method in routine hospital services.

The tympanic and oral temperatures presented no statistical differences in healthy human adults.

The values of the tympanic temperature demonstrated difference only in relation to the angle of measurement and not to the right or left side.

## REFERENCES

1. Guyton AC. Fisiologia humana. 6.ed. Rio de Janeiro: Guanabara Koogan; 1988. p.443-54.
2. Chaud MN, Peterlini MAS, Harada MJCS, Pereira SR. O cotidiano da prática de enfermagem pediátrica. São Paulo: Ateneu; 1999. p.89-91.
3. Doyle F, Zehner WJ, Terndrup TE. The Effect of Ambient Temperature Extremes on Tympanic and Oral Temperatures. *Am J Emerg Med* 1992; 10:285-89.
4. Wilson RD, Knapp C, Traber DL, Priano LL. Tympanic thermography: a clinical and research evaluation of a new technique. *South Med J* 1971; 64(12):1452-55.
5. Jensen BN, Jensen FS, Madsen SN, Lossi K. Accuracy of digital tympanic, oral, axillary, and rectal thermometers compared with standard rectal mercury thermometers. *Eur J Surg* 2000; 166:848-51.
6. Kocoglu H, Goksu S, Isik M, Akturk Z, Bayazit YA. Infrared tympanic thermometer can accurately measure the body temperature in children in an emergency room setting. *Int J Pediatric Otorhinolaryngol* 2002; 65:39-43.
7. Yaron M, Lowenstein SR, Mclain JK. Measuring the accuracy of the infrared tympanic thermometer: correlation does not signify agreement. *J Emerg Med* 1995; 13(5):617-21.

8. Barros Neto B, Scarminio IS, Bruns RE. Planejamento e otimização de experimentos, Campinas: Unicamp; 1995. p.299.
9. Mamede MV, Carvalho EC, Cunha AMP. Técnicas de enfermagem. São Paulo: Savier; 1981.
10. Greenleaf JE, Castle BL. External auditory canal temperature as an estimate of core temperature. *J Appl Physiol* 1972; 32(2):194-98.
11. Giuliano KK, Giuliano AJ, Scott SS, Maclachlan E, Pyszniak E, Elliot S, *et al.* Temperature measurement in critically ill adults: a comparison of tympanic and oral methods. *Am J Cr Care* 2000; 9(4):254-61.

Recebido para publicação em 8 de maio e aceito em 14 de agosto de 2003.

