

Comparison of Tympanic and Rectal temperature in febrile pediatric patients admitted in Niloufer hospital

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Abstract

Objective: To compare Tympanic membrane temperature and Rectal temperature in Febrile pediatric patients and compliance for the subjective methods. **Design:** Prospective observational descriptive study. **Setting:** children between the age group of 6 months to 12 years who were admitted with fever were randomly taken for the study for a period from Jan 2013 to July 2014) in Institute of Child and Women Health, Niloufer Hospital, Osmania Medical College, Hyderabad. **Participants:** During the study period, 588 children both male and female admitted with fever were chosen for the study. **Methods:** Five hundred and eighty eight children between the age group of 6 months to 12years in pediatrics department admitted in Niloufer Hospital were randomly taken during the period of study from 2013 January to 2014 July. Rectal temperature and two readings of Ear temperature from each side were taken and compared. It's an observational study. **Results:** Mean rectal temperature was 39.42+/- 0.59°C. Mean temperature of both ears was 39.47+/- 0.6°C. The mean temperature difference between ear and rectal temperature was 0.004+/- 0.08°C. Patient resistance was more to the rectal temperature measurement (74.2%) when compared to the ear temperature measurement (25.8%). There was a clear preference by all the respondents (parents) towards ear thermometry, which was rated higher in terms of rapidity, ease of measurement and cleanliness associated. **Conclusions:** In this study it has been shown that ear temperature correlates well with "core" body temperature. It is time to consider whether tympanic thermometry can take over from traditional methods of temperature measurement.

Keywords: Rectal temperature, Tympanic membrane temperature, Parental assessment, Rapidity, Easy, Clean

I. Introduction

Fever is a very common complaint in children accounting for as many as 20% of pediatric visits to doctors. A patient's temperature is a critical vital sign that may be used by Emergency Department (ED) clinicians to determine the degree of illness and the need for further assessment and intervention¹. Accurate body temperature measurement is necessary for the timely detection and management of fever, as well as evaluating treatment effectiveness. There are invasive methods which include esophageal, rectal and bladder measurements¹. Rectal temperature is considered the least invasive among these invasive temperature measures, and often is assumed to approximate core temperature². Noninvasive temperature measurement methods include oral, temporal artery (TA), axillary and aural [tympanic membrane (TM)] measurements^{3,4}. All types of temperature measurements have advantages and limitations related to accuracy and precision, as well as practicality and feasibility in the ED setting. Fever (pyrexia) may be defined in both pathophysiological and clinical terms: Interleukin-1 (IL-1) elevates the thermoregulatory set point of the hypothalamic center. In response to an upward displacement of the set point, an active process occurs in order to reach the new set point. This is accomplished physiologically by minimizing heat loss with vasoconstriction and by producing heat with shivering. Behavioral means of raising body temperature include seeking a warmer environment, adding more clothing, curling up in bed, and drinking warm liquids. Clinically, fever is a body Temperature of 1°C (1.8°F) or greater above the mean at the site of temperature recording. The importance of at least 1°C higher than the mean temperature lies in the diurnal variation of normal body temperature, which reaches its highest level in early evening (5-7p.m.). Diurnal temperature fluctuations are greater in children than in adults and are more pronounced during febrile episodes. In young children, a relatively high rectal temperature predominates, with a gradual decrease towards adult levels beginning at 2 years of age. This trend stabilizes soon after puberty⁵.

Many decisions concerning the investigation and treatment of children are based on the results of temperature measurement alone. An incorrect temperature measurement could result in the delayed detection of a serious illness or alternatively an unnecessary septic workup. Despite the plethora of instruments that have

become available in the last 30 years, there remains considerable controversy as to the most appropriate thermometer and the best anatomical site. The most accepted method for accurate determination of body temperature in non neonatal ambulatory children is by rectal temperature⁶ which is often considered the “gold standard” for clinical use. However, rectal temperature measurement is inconvenient, invasive, time consuming and potentially painful and may lead to non-compliance behavior in some children and may not be acceptable to the parents⁷. The tympanic membrane has same vascular supply as that of the hypothalamus and is an excellent, readily accessible site for core temperature recording.

Infrared thermometers which were used to measure temperature at the external ear canal have become available in the past 15 years and have been introduced into widespread clinical use^{8,9,10}.

This study was designed to compare the performance of two commercially available thermometers, one a rectal digital thermometer and the other an infrared tympanic membrane thermometer and also to assess the compliance of the method preferred.

II. Material And Methods

A prospective observational cross sectional descriptive study was designed and study setting included 588 children of age group between 6 months to 12 years who were admitted with fever and were randomly taken from the department of pediatrics, Niloufer Hospital Hyderabad. The period of study is from January 2013 to July 2014. It's an observational study.

Inclusion criteria:

- Children between the ages of 6 months to 12 years with fever.

Exclusion criteria:

- Children less than 6 months of age.
- Those with suppurative otitis media.
- Those with otitis externa.
- Those with moderate to large amount of wax.
- Those with CSF leaks.
- Those with anal fissures.
- Those receiving enemas.

A cutoff of 37.6°C for each device is kept to define a febrile patient.

The following data was collected: Name, Age, Sex Duration of fever in days, presence of cerumen or otitis media by otoscopic examination, Perineal examination was done, Rectal temperature and two readings of Ear temperature from each side were recorded. The Ambient temperature was measured by using a mercury column thermometer. Rectal temperature is obtained by using a digital electronic thermometer and ear temperature is measured by using Braun Thermoscan instant Thermometer IRT 3520. The instruments were pre-calibrated. The offset or calibration factor of infrared thermometer to compensate for difference between ear temperature and that measured from other sites is $\pm 0.4^{\circ}\text{C}$ (preset by the manufacturer). For measuring the Tympanic membrane temperature the probe was gently introduced into the ear canal and oriented towards the contra-lateral ear, while traction (ear tug) is applied to the pinna. In children less than one year of age, traction was applied posteriorly while in older children it was in the postero-superior direction. The trigger is depressed till an audible beep is heard signaling calibration with body temperature (for two seconds). The plastic probe cover changed with each measurement. The measurement is repeated as soon as possible after the instrument's electronic circuitry had reset. Rectal Temperature measured by applying a sterile lubricant jelly on the probe and following proper positioning of the child (e.g. face down over mother's lap, child in Left lateral position), the buttocks are separated and the thermometer is inserted without force up to a distance of 2cm into the rectum. Reading in the thermometer is obtained after hearing an audible beep is heard signaling calibration with body temperature. For each child, rectal probe prior to insertion is covered by disposable plastic protector. Attempts were made to take all readings in a patient within five minutes and in following order: ear temperature then rectal temperature. After measurements, parental and patient preference is assessed for both techniques. A comparison in terms of rapidity, ease of technique and cleanliness was noted and resistance on the part of patient was observed.

III. Results

Total of 588 children of age ranging from 6 months to 12 years admitted in the department of pediatrics Niloufer Hospital Hyderabad were randomly chosen for the study.

The data was analyzed using SPSS for windows version 1.0 and following statistical methods were applied.

- Descriptive statistics which includes mean, standard deviation and range to know the nature of sample, age and group wise.
- Product moment correlation to find out the relationship between tympanic and rectal temperature among different age groups.
- Graphical representation of these two different methods of temperature measurement on x and y axis.

TABLE 1: DESCRIPTIVE STATISTICS OF THE SAMPLE SELECTED

Gender	No. of cases	Range of age		Mean(years)	S.d.(years)
		minimum	maximum		
Male	288	6m	12y	4.87	2.72
Female	300	6m	12y	4.41	2.35
Total	588	6m	12y	4.64	2.53

The mean age of male children was found to be 4.87 years, and that of female children was 4.41 years. There is no significance between groups ($p < 0.05$).

TABLE 2: DESCRIPTIVE STATISTICS FOR RECTAL TEMPERATURE FOR THE ENTIRE SAMPLE

Temperature	N	Minimum °c	Maximum °c	Range °c	Mean °c	S.d. °c
Rectal	588	38.11	40.74	2.63	39.42	0.59

TABLE 3: DESCRIPTIVE STATISTICS FOR TYMPANIC TEMPERATURE FOR THE ENTIRE SAMPLE

Ear temperature	Readings	N	Minimum °c	Maximum °c	Range °c	Mean °c	S.d. °c
		Right ear	Reading1(R1)	588	38.16	40.96	3
	Reading2(R2)	588	38	41	3	39.5	0.636
Left ear	Reading1(L1)	588	37.84	40.99	2.94	39.14	0.636
	Reading2(L2)	588	38	41	3	39.5	0.636

FIGURE 1: COMPARISON OF EAR AND RECTAL TEMPERATURES ACROSS DIFFERENT AGE GROUPS

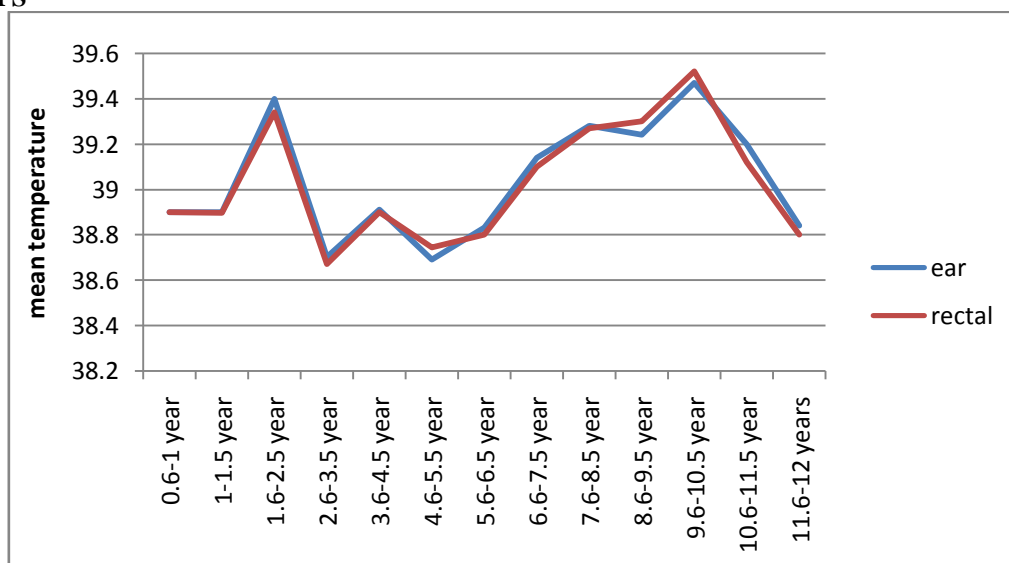


TABLE 4: COMPARISON OF RESISTANCE DURING 2 DIFFERENT MODES OF TEMPERATURE MEASUREMENTS

Type	Patient resistance			
	Yes		No	
	No. of patients	%	No. of patients	%
Ear	110	18.7	478	82.3
Rectal	436	74.2	152	25.8

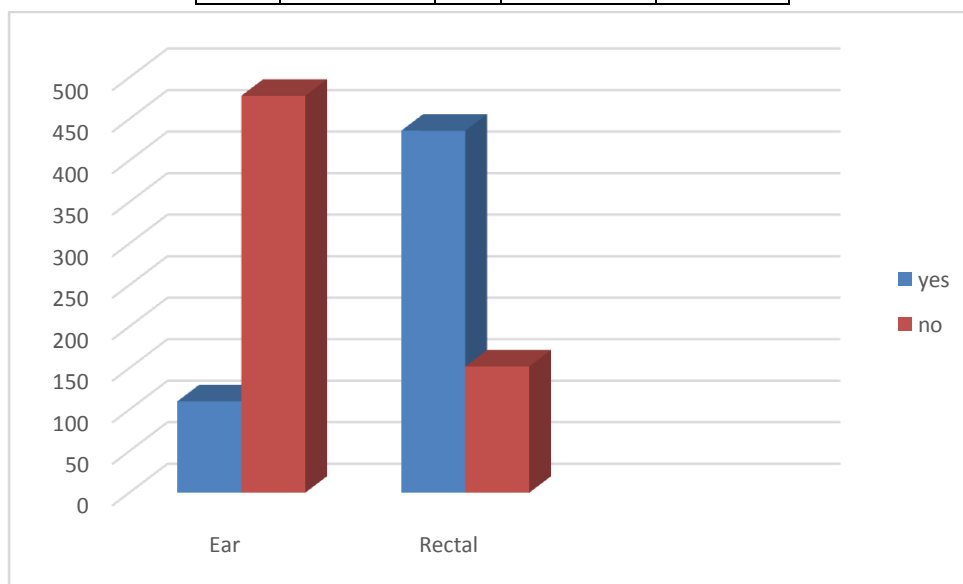


FIGURE 2: COMPARISON OF RESISTANCE DURING 2 DIFFERENT MODES OF TEMPERATURE MEASUREMENTS

TABLE 5: ACCEPTABILITY BY PARENTS FOR METHOD OF TEMPERATURE MEASUREMENT

Rapidity		Ease of measurement		Cleanliness associated	
Ear	Rectal	Ear	Rectal	Ear	Rectal
Yes by	No by	Yes by	No by	Yes by	No by
588	588	588	588	588	588
Parents	Parents	Parents	Parents	Parents	

There was a clear preference by all the respondents (parents) towards ear thermometry, which was rated higher in terms of rapidity, ease of measurement and cleanliness associated. There was no case where parents were indecisive on these.

IV. Discussion

Tympanic thermometry is a new concept and not much research work has been done using this. Results of our study are in agreement with the previous work of Talo, *et al.*¹¹ had demonstrated significantly large ($P = 0.01$) correlations between temperatures in the left and right ear. There was good correlation between TMT and RT in both the groups. Terndrup, *et al.*¹² found excellent correlations ($r = 0.90$) between TMT and RT in 102 patients (age unspecified).

TABLE 6: COMPARISON OF NUMBER OF CASES, AGE RANGE, GENDER AND MEAN AGE WITH OTHER STUDIES

	Arvind Sehgal <i>etal</i> 2002 ¹³	Bernardo <i>etal</i> 1996 ¹⁴	Thomas E Terndrup <i>etal</i> 1991 ¹²	Beck strand <i>etal</i> 1996 ¹⁵	present study
No. of cases	60	38	303	81	588
Age Range in Years	0.6-9	1 to 14	<16	0.06-2	0.6-12
Gender(M/F)	31/29	----	176/127	---	300/288
Mean Age in Years	4.47+/-2.5	6.9	1.6+0.9	0.5	4.64±2.53

Our findings are in well correlation with other studies also. TMT is considered as an excellent indicator of core body temperature is important in dynamic situations where the patient’s core temperature is changing rapidly. In the present study too, high correlations between TMT and RT were observed.

TABLE 7: COMPARISON OF MEAN TEMPERATURE DIFFERENCE BETWEEN EAR AND RECTAL READING (IN °C) WITH OTHER STUDIES.

No.	Studies	Mean Temperature Difference Between Ear and Rectal Readings (in °c)
1.	Present Study	0.004
2.	Arvind Sehgal et al., ¹³ 2002	0.01
3.	Loveys et al., ²¹ 1999	-0.09
4.	Wilshaw et al., ²³ 1999	0.20
5.	Hoffman et al., ²⁴ 1999	0.18
6.	Draaisma et al. ¹⁶ 1997	-0.01
7.	Beckstrand et al. ¹⁵ 1996	-0.05
8.	Hooker et al., ¹⁹ 1996	0.29
9.	Bernardo et al., ¹⁴ 1996	0.29
10.	Brennan et al., ¹⁸ 1995	0.37
11.	Petersen Smith et al. ¹⁷ 1994	0.05
12.	David et al., ²⁰ 1993	0.13
13.	Stewart et al., ²² 1992	0.20

The tympanic membrane which shares a common blood supply with the hypothalamus, the thermostat of the body, makes it a potential site for measurement of temperature in these babies. On comparing both the techniques, TMT is an easy, rapid and clean procedure with no contact with mucous membrane and is acceptable to parents and children. Added advantages include lack of influence of factors known to spuriously affect oral temperature like (e.g. recent fluid intake, mouth breathing, and tachypnea. Coefficient of correlation in present study was 0.991(r). Correlations between Tympanic and Rectal readings were highly significant. Arvind Sehgal et al.¹³ and Terndrup TE et al.,¹² also found excellent correlation (r = 0.994 and r = 0.90 respectively) between the two readings. From the figure 1, it was observed that a perfect correlation existed between the ear and rectal temperature which implies that ear temperature can be used successfully to predict the core body temperature.

	Arvind Sehgal etal 2002 ¹³	Terndrup TE etal 1991 ¹²	present study
coefficient of correlation	0.994	0.9	0.991

Ambient temperature was included as a co-variable, because the thermometer uses a microprocessor to self-calibrate based on the ambient temperature. In the present study, it was found that the ambient temperature had no significant influence on tympanic thermometer readings from both the ears. In the study done by Brinnel et.al.,²⁵ it was found that ear temperature changes by 0.0025°C per 1°C change in ambient temperature. In the Zehner et.al.²⁷ study, it was observed that oral temperature and ear temperature have a predictable relationship to rectal temperature at normal ambient temperature. However, in areas with higher ambient temperature (35°C), spuriously elevated oral and ear temperature may occur.

Our results showed that it is better to use a technique for measuring the child’s body temperature that is more convenient, painless, and safer than rectal temperature. Tympanic thermometry as per the manufacturer’s literature has many advantages are listed, not least the safety and speed with which a measurement can be made, a great bonus for those who work with children. Compared with the rectal temperature, electronic ear thermometers have been welcomed because measurement can be taken in 1–2 seconds.²⁶ over the past few years, infrared ear thermometers have become very popular and some hospital trusts have recommended that ear thermometers replace all previously used electronic thermometers. It is known that other areas of the brain are involved in thermoregulation so estimation of the hypothalamus may not be as significant as once thought. Nevertheless, the tympanic membrane has a good blood supply (from the deep auricular branch of the internal maxillary artery, the stylomastoid branch of the posterior auricular artery, and the tympanic branch of the maxillary artery) so the temperature at the tympanum is probably the best one can get as an indirect measure of brain temperature.

Some authors²⁸ appear to be confident of the accuracy of ear thermometers, reporting good agreement between the temperatures of the ears. We have shown that, in a constant and comfortable environment there are no notable differences between the temperatures of the ears in the children. We found that in healthy, afebrile children the temperature of one ear can, in the worst case, differ from the other ear by not more than half a degree.

In the febrile child, the difference between the ears is minimal. The ranges of differences are the same in the febrile patients as they are in the afebrile children (1.2°C). We are clear that there is no difference in one ear compared to the other .

Both of ear thermometers are detected a rise in core temperature caused by fever²⁹ or exercise,³⁰ .There are claims that ear temperature represents hypothalamic temperature and therefore the true core temperature. We are convinced that ear temperature is gold standard for core body temperature measurement than for rectal temperature.

SUMMARY

- A total of 588 children admitted in pediatrics department in niloufer hospital were enrolled in this study.
- The ages ranged from 6 months to 12years.
- Maximum numbers of cases were below age groups of 2.5years.
- Male were 300 and females were 288 in number.
- Mean age was 4.64 years
- Maximum cases were Acute Respiratory Infection (31.8%)
- Mean rectal temperature was 39.42+ 0.59°C
- Mean temperature of both ears was 39.47+ 0.6°C.
- The mean temperature difference between ear and rectal temperature was 0.004+ 0.08°C
- Patient's resistance was more to the rectal temperature measurement (74.2%) when
- Compared to the ear temperature measurement (25.8%).
- There was a clear preference by all the respondents (parents) towards ear thermometry, which was rated higher in terms of rapidity, ease of measurement and cleanliness associated.

V. Conclusion

Ear is the most convenient site for pediatric temperature measurement and in this study it has been shown that ear temperature correlates well with “core” body temperature. It has good compliance with children and is a satisfied method for parents. Temperature recording is particularly upsetting for the younger child and it is time to Consider whether tympanic thermometry can take over from traditional methods of temperature measurement. Rectal thermometry has a risk of perforation and also a time taking procedure when compared to ear temperature. So it can be taken over by tympanic membrane thermometry.

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