RESEARCH ARTICLE

Inadvertent hypothermia in paediatric radiotherapy practices under sedation: a single centre observational study

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Abstract

Objective: To detect changes in body temperature during outpatient procedures and to identify factors associated with hypothermia in the paediatric population undergoing radiotherapy under sedation.

Method: The observational study was conducted between July and October 2022 at Ankara City Hospital, Turkey, and comprised paediatric cancer patients aged from 1 month to 18 years who needed sedation or general anaesthesia during radiotherapy. Baseline body temperature T1 was measured before transportation to the radiotherapy room, while body temperature T2 was taken after radiotherapy. Data was analysed using SPSS 20.

Results: A total of 152 radiotherapy sessions related to 13 children were evaluated. There were 8(61%) boys and 5(38%) girls with overall mean 4.46±3.45 years (range: 2-13 years). The mean body surface area as 0.70±0.212. Radiotherapy was performed in 9(69%) patients, while 4(31%) patients underwent tomotheraphy. The dose used was 180cGy in 12(92.3%) patients. Hypothermia was observed in at least one session in 12(92.3%) patients. There was significant difference in body temperature at baseline and post-radiotherapy ($p<0.05$).

Conclusion: There were significant changes in body temperature during outpatient procedures in the paediatric population undergoing radiotherapy under sedation.

Key Words: Anaesthesia recovery period, Hypothermia, Paediatrics, Radiotherapy.

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Introduction

Radiotherapy (RT) is a common treatment modality for childhood malignancies. Immobilisation of children using restraint devices is mandatory during RT to preserve healthy tissues and to achieve a more accurate radiation dose distribution that is continuously focussed on the target volumes. Repetitive daily sedation or general anaesthesia (GA) is required to provide immobilisation during RT, especially in children aged 0-5 years and in patients with mental retardation[1].

However, sedation and GA reduce the ability to regulate body temperature and cause hypothermia susceptibility, especially in the paediatric patient group.

Inadvertent perioperative hypothermia (IPH) is defined as a core body temperature <36.0°C at any time of the operation. According to the Association of perioperative Registered Nurses (AORN) guidelines, hypothermia in patients undergoing surgery is a condition that should be prevented and treated[2].

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Children are at a higher risk of IPH as they lose more heat by conduction and radiation than adults, due to a higher surface area/volume ratio, less brown adipose tissue, and higher basal metabolic rates. Infants, on the other hand, have an immature hypothalamic thermoregulatory capacity and high resting vagal tone, which makes thermoregulation by vasoconstriction less effective[3]. In addition, GA or sedation limits the body's thermoregulatory mechanisms, raises the threshold temperature range by the thermoregulation centre, which is one of the factors that facilitate intraoperative hypothermia. The direct effects of GA are responsible for the initial rapid drop in core temperature. Risk factors for IPH in paediatrics are young age, length of surgery >30min, major surgery and temperature <36.5°C before anaesthesia induction[4].

The current study was planned to detect changes in body temperature during outpatient procedures, and to identify factors associated with hypothermia in paediatric cancer patients undergoing RT under sedation.

Patients and Methods

The observational study was conducted between July and October 2022 at Ankara City Hospital, Turkey. After approval from the institutional ethics review committee, the study was registered at ClinicalTrials.gov (date: July 27, 2022; ID: NCT05478850)

Those included were paediatric cancer patients aged from 1 month to 18 years who needed sedation or GA during RT. Those having chronic nausea and vomiting complaints, active infection, apnoea history, cardiac disease, kidney and liver failure, anomalies that may cause difficult airway, metabolic diseases, and neurological or muscular diseases were excluded.

The study included all sessions of children aged 0-18 years who received radiotherapy under sedation in the radiation oncology department of the hospital between July and October 2022.

Written informed consent was obtained from all the parents. Baseline body temperature T1 was measured before transportation to the RT room, while body temperature T2 was taken after RT. The temperature was measured in Celsius (°C) with an infrared thermometer without contact to the skin (Braun No touch + forehead thermometer, BTF300USV1, Germany). The body temperatures were recorded by the same anaesthetist. Temperature change ΔT was defined as T2 minus T1. Staff members were blinded to the initial temperature to avoid changes in the clinical management of the patient. The room temperature was constant at 24°C.

Before RT, in addition to T1, patient's age, body weight, body mass index (BMI), body surface area (BSA), American Society of Anaesthesiologists (ASA)[5] physical status and fasting time were recorded.

The anaesthesia type was decided by the staff anaesthetist, with the depth of anaesthesia as stage 2, according to the Paediatric Sedation Status Scale[6]. Duration of anaesthesia was also noted. Complications were defined as desaturation, meaning saturation of peripheral oxygen (SpO2) <92%, hypoventilation, airway spasm, bradycardia, and tachycardia. They were recorded during the procedure and during recovery. Sedation scale during the procedure, Modified Steward Score (MSS)[7] and discharge time were recorded post-procedure.

At the end of the procedure, the patient was observed in the recovery room until the MS was ≥8, and the discharge time was recorded. The time from the end of RT to MSS 8 was defined as the discharge time.

The sample size was determined using G*Power 3.1.9.2 package[8] while keeping effect size d 0.44, power 95% and error level 0.05 and in the light of a study which investigated the temperature change during magnetic resonance imaging (MRI) in children[9]. Since the current study focussed on analysing the impact of anaesthesia on body temperature in children receiving RT, it was determined that a change of 0.2°C in core temperature would be considered significant due to the potential inhibitory effect of anaesthesia on the body's thermoregulatory mechanism. Typically, this mechanism is triggered by changes of approximately 0.2°C [10].

Data was collected by selecting children who met certain criteria through a consecutive sampling method and taking their temperature measurements on a daily basis.

Data was analysed using SPSS 20. Data was expressed as mean, with standard deviation, median with interquartile range and frequencies with percentages, as appropriate. Shapiro-Wilk test was used to examine the conformity of continuous data to normal distribution. Wilcoxon test was used to compare T1 an T2 values. Mann Whitney U test was used to compare the fasting time and anaesthesia time of those who developed hypothermia and those who did not. Relationship between continuous data was analysed using Spearman's correlation coefficient. $P<0.05$ was taken as statistically significant.

Results

A total of 152 radiotherapy sessions related to 13 children were evaluated. There were 8(61%) boys and 5(38%) girls with overall mean 4.46±3.45 years (range: 2-13 years). The mean BSA as 0.70±0.212. RT was performed in 9(69%) patients, while 4(31%) patients underwent tomotheraphy. The dose used was 180cGy in 12(92.3%) patients (Table 1).

Table-1: Patient characteristics.

Characteristics		Mean ± SD
Years		4.46±3.45
Height (cm)		105.38±22.45
Weight (kg)		17.15±7.04
Body Mass Index (kg/m2)		15.29±2.90
Body Surface Area (m2)		0.70±0.21
Gender	**n**	**%**
Female	5	38.5
Male	8	61.5
Radiotherapy	9	69.2
Tomotherapy	4	30.8
RT dosage		
180 cGy	12	92.3
500 cGy	1	7.7

RT: Radiotherapy.

The ASA status of all patients was II. Overall, 5(38.4%) patients had a diagnosis of medulloblastoma, and 3(23%) ependymoma. RT was applied locally to the cranial region in 5(38.4%) patients, while craniospinal radiotherapy was applied in 6(46.2%) cases. Respiratory and haemodynamic complications post-anaesthesia were not observed in any

Table-2: Baseline body temperature, post-procedure body temperature (T2) and the difference between the two (ΔT).

	Mean ± SD	Median (IQR)	p value*
T1(°C)	36.47±0.38	36.4 (36.2-36.7)	<0.001
T2(°C)	36.05±0.35	36.05 (35.8-36.3)	
ΔT(°C)	-0.41±0.30	-0.4 (-0.6 – -0.2)	

*Wilcoxon test
SD: Standard deviation, IQR: Interquartile range.

patient.

There was significant difference in body temperature at baseline and post-RT (p<0.05) (Table 2). Hypothermia was observed in at least one session in 12(92.3%) patients. T2 values decreased in 142(93.4%) sessions, increased in 6(3.9%), and remained unchanged in 4(2.6%). Severe hypothermia (≤35°C) was not observed in any patient.

When hypothermic and normothermic sessions were compared, no difference was found between fasting times (p>0.05), while anaesthesia and discharge times were significantly higher in hypothermic sessions (Table 3).

Table-3: Comparison and correlation of parameters in hypothermic and normothermic patients according to sessions.

	Hypothermia Mean ± SD Median (IQR)	Normothermia Mean ± SD Median (IQR)	p**
Fasting time (h)	9.16±1.04 9 (8-10)	9.23±1.03 9 (8-10)	0.838
Anaesthesia time (sec)	475.30±335.21 349 (219-661)	723.36±450.98 672 (300-996)	<0.001
Discharge time (min)	14.81±1.61 15 (15-15)	15.47±1.40 15 (15-15)	0.008

**Mann Whitney U test. SD: Standard deviation, IQR: Interquartile range.

No correlation was found between T2 values and fasting time (p>0.05). A negative correlation was found between T2 values and duration of anaesthesia (r=-0.291, p<0.001). A negative correlation was found between T2 values and time to discharge (r=-0.261, p<0.001) (Table 4).

Table-4: Correlation of body temperature post-procedure (T2) values with fasting time, anaesthesia time and discharge time.

	T2 r*	p
Fasting time (h)	0.037	0.649
Anaesthesia time (sec)	-0.291	<0.001
Discharge time (min)	-0.261	0.001

* Spearman's correlation coefficient.

Discussion

Anaesthesia practices during paediatric RT have many challenges that differ from routine operating room (OR) and non-OR anaesthesia practices. The most prominent of these are the remote setting of the unit, patient monitoring with cameras from outside the room during RT, and titration of the depth of anaesthesia at a level that may prevent the patient's movement without causing life-threatening complications[11].

The current study showed that hypothermia, which is an important clinical finding, was frequently seen in fragile, paediatric cancer patients during RT sessions. To our knowledge, there is no hypothermia study in literature on paediatric cancer patients who received RT under sedation. The current study showed that hypothermia was also seen in children under sedation during non-OR procedures. While hypothermia was observed in at least one session in 12(92%) of the 13 patients, hypothermia was detected in 50% of the total sessions. While the lowest measured body temperature was 35.2°C, the mean body temperature was 36.47±0.38°C before the procedure and 36.05±0.35°C after the procedure. According to the study, hypothermia was correlated with duration of anaesthesia, and prolonged the discharge time. Age, gender, weight, BSA, RT dose and type, and fasting duration were not significantly associated with hypothermia.

Similar to the current study, Lo et al. found hypothermia in 52% sedated children during MRI scans. The mean baseline temperature was 36.2±0.5°C, and mean post-procedure temperature was 35.9±0.6°C. The mean temperature change was -0.28±0.6 (p<0.05). Baseline temperature was negatively correlated with the frequency of post-procedure hypothermia[12].

Madsen et al. found mean baseline and post-MRI temperatures of 36.9°C and 36.7°C, respectively. The mean temperature change in all groups was -0.24[10].

Cronin et al. found a median temperature of 35.7°C, and a 63% incidence of hypothermia in children undergoing MRI under sedation. There was no relationship of hypothermia with age, weight, duration of anaesthesia, demographic characteristics, or heart rate. Also, there was no difference in the length of stay in post-anaesthesia care unit (PACU) in relation to the patient's hypothermic state[13].

Pearce et al. reported that intraoperative hypothermia was found in 52% children who underwent invasive and non-invasive procedures. Older age, longer anaesthesia duration, greater blood loss and transfusion rates were

significantly associated with hypothermia[14].

In an animal study with Wistar Albino rats, it was shown that after RT was applied to the brain, it provided the protection of progenitor cells in the subventricular zone in rats that were kept in a hypothermic area at 30°C for 8 hours[15].

The current study is the first to analyse hypothermia in oncological paediatric patients undergoing RT under sedation.

The current study also has limitations as, owing to a small sample, it could not find any positive or negative clinical effect of hypothermia. Future studies with larger samples comprising patients with different characteristics are recommended.

Conclusion

There were significant changes in body temperature during outpatient procedures in the paediatric population undergoing radiotherapy under sedation.

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Conflict of Interest: None.

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