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The effect of forced-air warming blanket position during spinal surgery on patients' intra-operative body temperature

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ABSTRACT

Background: The use of body-warming systems is recommended by international anaesthesia societies for patients undergoing surgery. Limited research is however available on the influence of positioning of forced-air warming blankets for patients undergoing spinal surgery. This study aimed to investigate how patients' intra-operative body temperature was affected by the position of forced-air warming blankets while undergoing spinal surgery on a spinal table.

Design: A randomized comparative experimental study was conducted with 60 adult patients undergoing posterior spinal surgery.

Methods: Patients were randomized into full underbody (n = 30) or surgical access (n = 30) forced-air warming blanket groups. Intra-operative body temperature was recorded at regular time intervals. The student's T-test, Chi-square, and MANOVA tests were performed to determine the differences between the two groups.

Results: Intraoperative hypothermia was significantly lower in the full underbody group than in the surgical access group (p = 0.020). The change in body temperature differed significantly between the two groups from 15 min until 240 min, with a mean difference of 0.5 °C.

Conclusion: The full underbody position of the forced-air warming blanket was effective for maintaining normal range core body temperature. The use of full underbody forced-air warming blanket for spinal surgery when patients are positioned on a spinal table in a prone position is recommended.

1. Introduction

Annually millions of elective and emergency surgeries are performed giving rise to many complications. Hypothermia during surgery is a common and often overlooked complication that increases a patient's risk for developing surgical site infections, delayed wound healing, coagulopathies and prolonged recovery [1–3].

General anaesthesia causes a decrease in a patient's body temperature of up to 2.8 °C within 2 h of inducing general anaesthesia.3, 4–6. Anaesthetic drugs are known to dysregulate thermoregulatory homeostasis [4]. In addition to the drop in patients body temperature due to anaesthetic drugs, the operating room temperature is set at 18 °C or lower to provide comfort for the surgical team wearing heavy protective gowns [5]. In some cases, hypothermia is exacerbated due to the use of the Jackson Table, a frame like bed specifically designed for patients to be operated in the prone position exposing a larger body surface area to the environment [6].

To combat perioperative hypothermia the use of active warming system is strongly advised for patients at risk for hypothermia and surgeries lasting longer than 30 min [7,8]. Active warming systems include electrical blankets, forced-air warming systems, electric mattresses, warmed intravenous fluid and warmed irrigation fluids [9,10]. Forced-air warming systems have demonstrated effectiveness in the prevention and management of hypothermia of a patient during the perioperative phase [11–13]. In addition, the use of forced air warming system was found to be cost-effective for patients and the healthcare system [14].

Patients undergoing spinal surgery are at risk for developing intraoperative hypothermia as surgery may take four to 8 h depending in the interventions required [15,16].

The forced air warming system blankets available to surgical teams for spinal surgery are for example underbody blankets and surgical access blankets. Studies done on the positioning of forced air warming blankets are limited to cardiac and abdominal surgeries, caesarean section as well as laparoscopic surgeries [17,18]. Most of these studies were done on patients operated on a solid table in the supine position.

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Currently there is limited evidence available on the positioning of a forced air warming blankets to prevent intraoperative hypothermia for patients undergoing spinal surgery on a Jackson Table [19]. We therefore report on how forced air warming blanket position influenced patient's intraoperative body temperature during spinal surgery on a Jackson Table.

2. Methods

This was a randomized comparative experimental study. Ethical approval was obtained from the Faculty of Health Research Ethics Committee, University of Pretoria (881/2020). Patients undergoing spinal surgery between January 2020 and December 2021 were recruited by the surgeon during pre-operative consultation. The inclusion criteria were adult patients (>18 years) requiring spinal surgery in the prone position using a Jackson Table, with surgery lasting for more than 3 h. The exclusion criteria were patients booked for cervical spinal surgery, anterior approach spinal cases, and spinal surgeries lasting less than 2 h such as spinal wound debridement and seroma drainage. Patients who gave informed consent to participate were randomized to either the full-underbody or surgical access blanket using the forced air warming system. A total sample size of 52 patients, 26 per group was calculated, with an 80 % probability that the study will detect a treatment difference at a two-sided 0.05 significance level, if the true difference between treatments is 0.6 units (°C) [20]. The sample size was increased to 30 patients per group to allow for a possible dropout of 15 %.

2.1. Procedures

All patients received a temperature sensing Rűsch Sensor Transurethral catheter (Teleflex Medical, Ireland), which recorded patients' intra-operative core temperature during the surgery. The two forced warming system blankets models (Bair Hugger™, 3M Medical, USA) used were the surgical access blanket model 570 and the full-underbody blanket model 635, both of which were connected to the 3M™ Bair Hugger™ warming unit (model 77,500). The temperature setting on the unit was set to 43 °C. The urinary catheter temperature probe was connected to the anaesthetic machine which continuously recorded core temperature.

Spinal surgery was done with patients in the prone position, and a HE-508 E Jackson spinal table (Howell, China) was used as the surgical bed. Patients received warmed intravenous fluid and the ambient temperature of the theatre was set to 18 °C.

2.2. Measurements

Preoperatively, we recorded patient characteristics including age, sex, body mass index (BMI), smoking status, and comorbidities. The primary measurement was intra-operative core temperature, which was captured every 15 min for the first hour and thereafter every 30 min until the end of surgery. The incidence of intraoperative hypothermia was recorded as well as intraoperative blood loss and duration of surgery.

2.3. Data analysis

Data were analysed using IBM Statistical Version 28. Measures of central tendency and dispersion were calculated to describe the sample. The Student's T-test and Chi-square test were used to compare patient characteristics between the two groups for continuous and categorical variables respectively. Multivariate analysis of variance (MANOVA) tests was performed to determine the differences in the intra-operative temperature readings between the two groups for different time points. A p-value <0.05 was considered significant.

3. Results

There were 200 patients screened for this study. A total of 60 patients participated in the study. Fig. 1 shows the flow of participants through the study.

Fig. 1 CONSORT 2010 flow diagram: Participant flow through the study.

3.1. Patient characteristics

Patient characteristics are summarised in Table 1. Patient characteristics did not differ significantly between the two groups, except for male-to-female ratio ($p = 0.001$).

3.2. Intraoperative outcomes

The overall incidence of intraoperative hypothermia was significantly lower in the full underbody blanket group than in the surgical access blanket group ($p = 0.020$) (Table 2). The severity of intraoperative hypothermia was not associated with blanket position ($p = 0.289$). Intraoperative blood loss did not differ significantly between the two groups ($p = 0.466$). The duration of the surgical procedure was, however, significantly longer in the full underbody group than in the surgical access group ($p = 0.026$).

The intraoperative body temperatures of patients in the two forced air warming system blanket groups are illustrated in Fig. 2. Patients in the different groups were compared for up to 240 min where both groups still had equal numbers of patients. The change in body temperature differed significantly between the two groups from 15 min until 240 min, with a mean difference of 0.5 °C. The mean intraoperative body temperature of the full underbody group was greater than 36 °C throughout the surgical procedure, thereby preventing intraoperative hypothermia. In contrast, the mean perioperative body temperature of the surgical access group was only 36 °C and above at 15 min ($n = 30$), 330 min ($n = 6$), and 360 ($n = 3$) min.

Fig. 2. Intraoperative body temperature between two positions of forced-air warming blankets. Error bars indicate standard deviations (SDs) of temperature. *$p < 0.001$ for group differences.

4. Discussion

In this randomized comparative experimental study, we investigated the effect of two different positions of forced air warming blankets on the intraoperative body temperature of patients undergoing spinal surgery. The incidence of intraoperative hypothermia was 27 % lower among patients in the full underbody group than among patients in the surgical access group. Notably, a similar study focussing on spinal surgery reported an even greater effect, with a 72 % lower incidence of hypothermia at the start of surgery among patients using underbody forced air warming blankets, in contrast to passive prewarming and active warming with a full body blanket granting surgical access [21]. The under-body forced air warming blanket has also exhibited superiority over resistive heating blankets in preventing hypothermia in patients undergoing major posterior approach spinal surgery [22].

Notably, patients in the full underbody forced air warming blanket group had normal mean intraoperative body temperatures throughout surgery, while patients in the surgical access groups only had normal intraoperative body temperatures at the first and last two time points of surgery. Importantly, patients in the underbody group underwent significantly longer surgeries than patients in the surgical access group. Although longer surgeries are usually associated with an increased risk of hypothermia [23], the underbody group still had a reduced incidence of hypothermia, whilst maintaining normothermia throughout surgery. This may be due to ambient intraoperative temperature having a negligible effect on core temperature when patients are warmed with forced air [24].

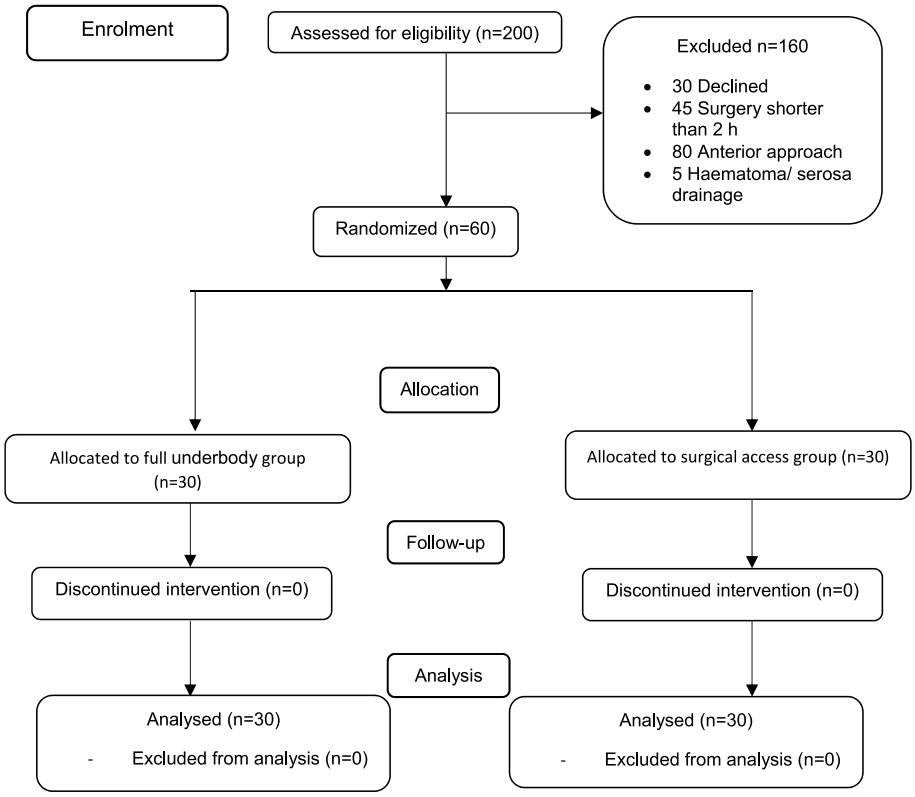

Fig. 1. CONSORT 2010 flow diagram: Participant flow through the study.

Table 1
Baseline patient characteristics.

Characteristics	Total group (n = 60)	Surgical access group (n = 30)	Full underbody group (n = 30)	P-Value
Age (years), mean ± SD	62.2 ± 11.9	62.2 ± 10.8	62.2 ± 13.1	0.542
Body mass index (kg/m^2), mean ± SD	29.7 ± 4.6	29.8 ± 4.4	29.6 ± 4.9	0.948
Sex (Male/Female)	23/37	15/15	8/22	0.001
Smoking, n (%)	4 (7 %)	1 (3 %)	3 (10 %)	0.309
Preoperative body temperature (°C), mean ± SD	36.3 ± 0.3	36.3 ± 0.2	36.3 ± 0.4	0.889
Comorbidities, n (%)				
Hypertension	26 (43 %)	14 (47 %)	12 (40 %)	0.606
Diabetes	3 (5 %)	1 (3 %)	2 (17 %)	0.309
Asthma	4 (7 %)	0 (3 %)	4 (10 %)	0.090
None	27 (43 %)	15 (50 %)	2 (37 %)	0.307

Table 2
Comparison of intraoperative outcomes between groups.

Variable	Surgical access (n = 30)	Full underbody (n = 30)	P-value
Intraoperative hypothermia (<36 °C), n (%)	26 (87)	18 (60)	0.020
Severity of intraoperative hypothermia, n (%)			0.289
Mild (35.5–35.9 °C)	9 (34.5)	7 (39)	
Moderate (35–35.4 °C)	9 (34.5)	6 (33)	
Severe (34.5–34.9 °C)	6 (23)	1 (6)	
Very severe (<34.5)	2 (8)	4 (22)	
Blood loss (ml), mean ± SD	861.7 ± 416.8	953.3 ± 542.8	0.466
Duration of surgical procedure (min), mean ± SD	290.9 ± 43.7	323.3 ± 64.2	0.026

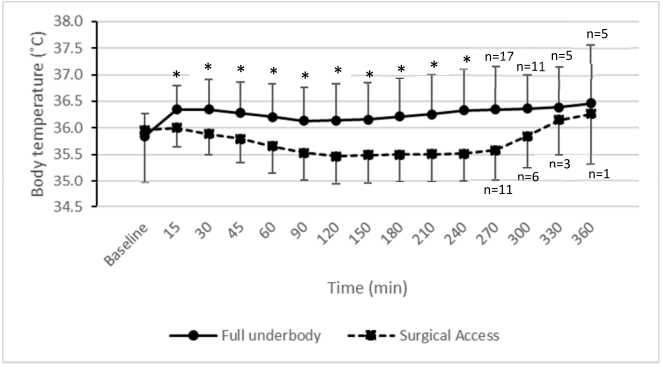

Fig. 2. Intraoperative body temperature between two positions of forced-air warming blankets. Error bars indicate standard deviations (SDs) of temperature. *p < 0.001 for group differences.

Mild hypothermia may result in platelet dysfunction and impaired clotting, which correlates with increased blood loss [19]. In our study, both groups had similar levels of blood loss even though the incidence of hypothermia was significantly different between the groups. Patients with normothermia undergoing lumbar spine surgery are known to experience increased blood loss [19], which might be explained by the location of surgery, periphery versus core temperature, and higher body temperatures during spinal surgery.

Our results align with recent studies including spinal surgery patients, collectively indicating the positive impact of underbody forced air warming blankets in preventing intraoperative hypothermia, despite prolonged surgery. The strengths of our study lie in its prospective randomized design and its valuable contribution to the limited body of research exploring the positional effect of forced air warming blankets on body temperature during spinal surgery. Future studies should use a larger sample size drawn from diverse settings. Investigating the effect

of pre-warming of patients before inducing general anaesthesia may also be worthwhile.

5. Conclusion

In conclusion, we investigated the effect of the forced air warming blanket position on the intra-operative body temperatures of patients during spinal surgery when positioned on a spinal table. We found that the full underbody forced air warming blanket was more effective in maintaining core body temperature within normothermia ranges. In practice, we recommend using a full underbody forced air warming for spinal surgery when patients are positioned on the spinal table in a prone position.

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Declaration of competing interest

We the authors of this paper declare no conflict of interest.

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