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The relationship between fragility scores and intraoperative body temperature changes in geriatric patients

Prospective observational research

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Abstract

Today, to evaluate morbidity and mortality in elderly surgical patients, fragility scores, which reflect the patient's current condition rather than increasing age, are used as a basis. Our research examines the association between fragility groups, body temperature changes, and inadvertent perioperative hypothermia (IPH) in major orthopedic surgery patients. Patients over the age of 65 who underwent major orthopedic surgery were evaluated. Body temperature measurements were taken tympanically preoperatively and every 5 minutes during surgery. Temperature changes (Δn) were calculated. Patients whose body temperature was below 36 °C were recorded as IPH. The Canadian Study of Health and Aging-Clinical Frailty Scale scoring system, consisting of 9 categories, was used for fragility scores. As the category number increases, the level of fragility increases. These categories are classified into 3 subgroups: Group F1 (Level 1–3), Group F2 (Level 4–7), and Group F3 (Level 8–9). Age groups: it is defined as Group A1 (66–74 years), Group A2 (75–84 years), and Group A3 (85<). The median (min–max) of surgery time was determined as 75 (35–131). For Δ35 (ºC), the differences between both fragility groups ($P = .054$) and the age groups ($P = .145$) were not significant. IPH frequency is 44.0% (n = 149). No difference was detected between hypothermia frequencies in the fragility groups ($P = .546$) and the age groups ($P = .065$). Nearly half of major surgery patients developed IPH. We did not find a relationship between both fragility groups and age groups and the frequency of IPH.

Abbreviations: IPH = inadvertent perioperative hypothermia, Tn = body temperature at the time "n", T_{pre} = preoperative body temperature, Δn = temperature change at the time "n".

Keywords: accidental, aged, body temperature, frailty, hypothermia, orthopedic surgery

1. Introduction

During surgery, especially after anesthesia, a significant decrease in body temperature occurs due to disrupting the thermoregulatory response mechanism. Except for therapeutic hypothermia, a decrease in body core temperature below 36 °C during surgery is called inadvertent perioperative hypothermia (IPH). It is one of the most common intraoperative complications. The type of surgery, anesthesia method, duration of surgery, temperature of the operating room, and temperatures of the fluids used during surgery may affect the frequency of hypothermia.[1,2]

IPH causes increased cardiac arrhythmia, surgical wound infection, and bleeding, so current patient safety guidelines strongly emphasize the importance of body temperature monitoring in the perioperative period.[1,2] In addition, necessary precautions should be taken to protect patients from hypothermia in the perioperative period and appropriate treatments should be administered to ensure normothermia.[3,4]

According to studies on perioperative hypothermia, one of the factors affecting the development of hypothermia is the patient's age.[5] Perioperative hypothermia causes increased morbidity and mortality, especially in elderly patients, so intraoperative temperature management is extremely important in this age group. Thermoregulatory responses are inadequate in elderly patients due to decreased skin and subcutaneous tissue, inadequate energy intake, and multiple systemic diseases. As a result, a significant decrease in body temperature can be observed in elderly patients undergoing surgery due to the effect of anesthesia and surgery.[6]

Some of the studies in today's literature have begun to consider fragility scores, which indicate the patient's current condition, instead of the patient's age, when examining morbidity and mortality in elderly surgical patients.[7–10] In our current

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literature review, we could not find sufficient studies examining the relationship between fragility scores, body temperature decrease, and IPH. Therefore, we planned this prospective observational study.

The aim of our research is to examine the connection between fragility scores and body temperature change, and the incidence of IPH.

2. Methods

2.1. Research method

The research is prospective, observational.

2.2. Patients inclusion and exclusion criteria

Patients over the age of 65 who underwent major orthopedic surgery at Kırsehir Training and Research Hospital between January, 01 2023 and October 01, 2023 were evaluated for the study.

Patients over the age of 65 who were scheduled for elective surgery by the Orthopedics and Traumatology Clinic, whose surgery duration was over 30 minutes, and who signed the consent form were included in the study. Patients who underwent femur fracture surgery, knee arthroplasty, and hip arthroplasty were evaluated for the study.

The study excluded patients who had emergency surgery, peripheral block anesthesia, congenital or acquired neurological diseases, and were treated for thyroid dysfunction. Patients whose body temperature was below 36 °C before the start of the surgical procedure, multiple blood product transfusions, and noradrenalin infusion were not followed up.

2.3. Ethics committee approval

Ethical consent for this study was given from the Ethics Committee for Clinical Investigations of Kırşehir Ahi Evran University (November 22, 2022 No: 2022-21/187). The research was conducted in accordance with the current Declaration of Helsinki. Informed consent of all the patients had been obtained. Clinical Trial Number: NCT06010069, Date: August 21, 2023.

2.4. Sample size

A preliminary study was initially conducted on 60 patients. The data of this preliminary study were evaluated with IBM SPSS 23.0 statistical program (IBM Corp., Armonk, NY). Surgical times of all operations were evaluated and median (min–max) values were determined as 75 (35–126) minutes. Temperature change data at the minimum surgery time (35th minute) obtained from the pretest was used to calculate the sample size. The total sample size was calculated as 339 with the G*Power 3.1.9.7 statistical program.[11] (F tests, ANOVA, α err prob = 0.05, power ($1 - \beta$ err prob) = 0.85, number of groups = 3, effect size f = 0.180).

2.5. Practice

During the preoperative evaluation, patients who met the inclusion criteria were informed about the study and volunteers were made to sign informed consent forms. Signatures were obtained from the relatives of highly fragile patients.

The patients' gender, age, American Society of Anesthesiology risk group, body mass index, operating room temperature, type of surgery, type of anesthesia, amount of intravenous fluid used perioperatively, anesthesia, and surgical procedure times were recorded.

Routine monitoring was performed on all patients undergoing surgical procedures. Routine monitoring: it includes noninvasive blood pressure, peripheral oxygen saturation, electrocardiography, and noninvasive body temperature measurement.

2.6. Body temperature measurements

It was performed tympanically with Braun IRT6520 (Braun, Germany). Body temperature measurements were measured preoperatively (T_{pre}), at the beginning of surgery and at 5-minute intervals throughout the surgery (T_n). Temperature changes (Δ_n) were calculated ($\Delta_n = T_{pre} - T_n$). Patients whose body temperature was detected below 36 °C at any time during the surgical procedure were recorded as IPH.

2.7. Fragility assessment

The Canadian Study of Health and Aging-Clinical Frailty Scale scoring system was used for fragility scores. Permission was obtained to use the scoring system.[12] This scoring system: it was developed by Rockwood et al. It consists of 9 categories created to evaluate the patient's baseline health status (CFS version 2.0). Each category refers to the patient's physical examination findings and daily activity level. It is evaluated subjectively by a practitioner experienced in the use of this index and it is determined which category the patient is in. It is understood that as the category number increases, functional capacity decreases and the level of fragility increases.

These categories classify them in 3 subgroups: in the first group (Level 1–3) (Level 1: Very Fit; Level 2: Fit; Level 3: Managing Well) In the second group (Level 4–7) (Level 4: Living with Very Mild Frailty; Level 5: Living with Mild Frailty; Level 6: Living with Moderate Frailty; Level 7: Living with Severe Frailty), in the third group (Level 8–9) (Level 8: Living with Very Severe Frailty; Level 9: Terminally Ill) is located.

In our research, these groups are: it is named Group F1 (Level 1–3), Group F2 (Level 4–7), and Group F3 (Level 8–9). During the preoperative anesthesia visit, patients were evaluated by a researcher experienced in using this scoring system, and The Canadian Study of Health and Aging-Clinical Frailty Scale was determined.

2.8. Evaluation of age groups

In this study, patients over the age of 65 were evaluated. Age groups: it is defined as Group A1 (66–74 years), Group A2 (75–84 years), and Group A3 (85<).

2.9. Interventions for hypothermia

During the surgical procedure, they are isolated with standard double-layer cotton surgical drapes. When body temperature is detected below 35 °C, patients are actively warmed with the Thermacare TC3249 (Gaymar, USA) heating system. Or passive heating is applied by covering the patient's body with heated cotton covers.

2.10. Statistics

IBM SPSS 23.0 (IBM SPSS Inc, Armock, IL) statistical package program was used to analyze the data. When evaluating the results, descriptive data were used: frequency (n), percentage (%), mean-standard deviation (mean ± SD), median, minimum–maximum or quartiles (median (min–max) or (Q1–Q3)), and 95% CI. Kolmogorov–Smirnov and Shapiro–Wilk tests were performed to examine the normality distribution of the data. $P < .05$ was considered statistically significant.

Two endpoints were determined for this study. Primary endpoint: is the detection of temperature changes (Δ_{35} and Δ_{75}). Comparisons between groups in both fragility groups and age groups were based on data on minimum surgery time (Δ_{35}). Since the data were not normally distributed, Kruskal–Wallis test was used for comparisons between groups.

Secondary endpoint: is the determination of the total IPH frequency. Chi-square (χ^2) test was used to compare data in groups.

3. Results

A total of 528 patients who underwent major orthopedic surgery were examined during the research. The data of 339 patients were evaluated statistically. The STROBE flow diagram is in Figure 1 and the basic characteristics data of the research are presented in Table 1.

Comparisons of temperature changes in fragility groups are presented in Table 2. The median (min–max) of surgery time was 75 (35–131). For comparisons between groups, both Δ_{35} (°C) and Δ_{75} (°C) data were evaluated. A Kruskal–Wallis test was performed on the fragility groups' scores (F1, F2, and F3).

For Δ_{35} (°C), the differences between the rank totals of 144.39 (F1), 176.78 (F2), and 174.38 (F3) were not significant (H (2, n = 339) = 6.076, P = .054).

For Δ_{75} (°C), the differences between the rank totals of 85.94 (F1), 98.49 (F2), and 149.38 (F3) were significant (H (2, n = 195) = 8.539, P = .010). Post hoc comparisons were conducted using the Tamhane tests. The temperature decrease in Group F3 was more significant than the other 2 groups. The difference between Group F3 and Group F1, 0.50 95% CI [0.15, 0.85], was statistically significant (P = .004). The difference between Group F3 and Group F2, 0.41 95% CI [0.86, 0.73], was statistically significant (P = .015). However, the difference between Group F1 and Group F2 –0.09 95% CI [–0.31, 0.12] was not statistically significant (P = .647).

Comparisons of temperature changes in age groups are presented in Table 3. A statistically significant were not detected for comparison between the age groups (A1, A2, and A3), both Δ_{35} (°C) and Δ_{75} (°C) with the Kruskal–Wallis test.

For Δ_{35} (°C), the differences between the rank totals of 162.99 (A1), 188.90 (A2), and 175.78 (A3) were not significant (H (2, n = 339) = 3.862, P = .145).

For Δ_{75} (°C), the differences between the rank totals of 93.69 (A1), 107.80 (A2), and 103.03 (A3) were not significant (H (2, n = 195) = 2.382, P = .304).

Hypothermia developed in a total of 149 (44.0%) patients. No difference was detected between hypothermia frequencies in the fragility groups (33 (47.1%) of 70 patients in Group F1, 112 (43.8%) of 256 patients in Group F2, and 4 (30.8%) of 13 patients in Group F3 (χ^2 (2, N = 339) = 1.211, P = .546)) (Table 4).

No difference was detected between hypothermia frequencies in the age groups (108 (48.4%) of 223 patients in Group A1, 23 (33.8%) of 68 patients in Group A2, and 18 (37.5%) of 48 patients in Group A3 (χ^2 (2, N = 339) = 5.459, P = .065)) (Table 5).

4. Discussion

In this observational study, we tried to answer the question, "Is the patient's fragility score effective in the occurrence of perioperative hypothermia in adults over 65 years of age?." We did not find an association between the fragility score increase and the body temperature decrease in the first 35 minutes. We found that there was more heat loss in the high fragility group only at the 75th minute. But overall, there was no association between IPH frequency and fragility groups. Similarly, there was no relationship between increasing age and decreasing body temperature.

Today, many very frail patients have to undergo surgical procedures. It has been shown that postoperative mortality of these fragile patients is high, even in surgeries with low and medium stress levels. Therefore, the study by Shinall et al emphasizes that frailty screening is necessary in all patients.[9] Inadvertent perioperative hypothermia is one of the factors that increase morbidity and mortality in surgical patients.[13] Studies have frequently investigated the relationship between IPH and age.[14,15] Additionally, many risk factors for hypothermia have been identified in these studies.[13,16] In this study, we discussed fragility, which has not been considered as a predictor for hypothermia until now.

In a retrospective cohort study by Zhang et al, IPH predictors were examined. In this study, the prevalence of IPH was 21.3%.[17] In particular, the age of the patient over 65 has been found to be a risk factor (age > 65 (OR = 1.561, 95% CI

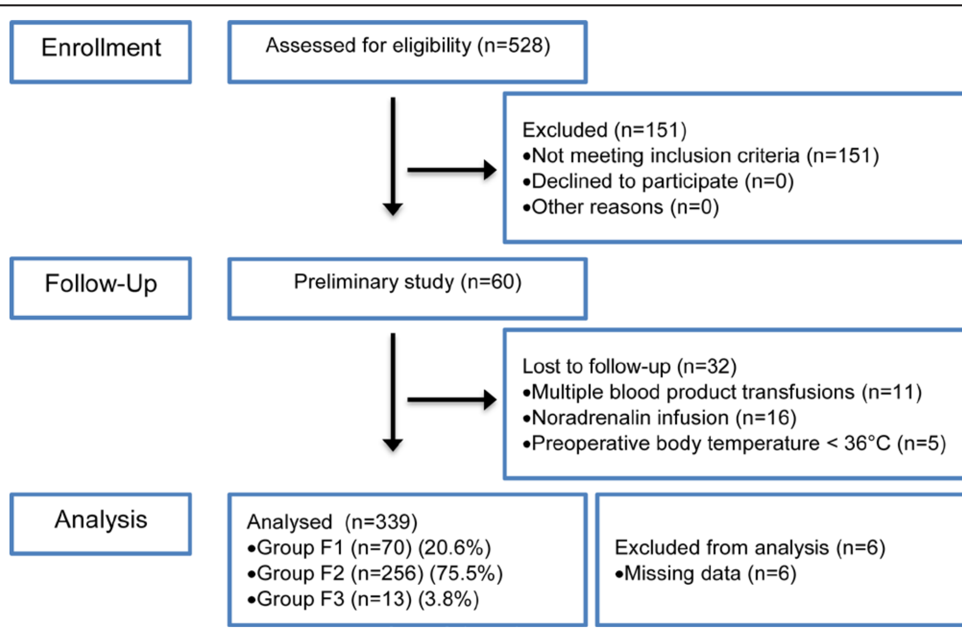

Figure 1. STROBE flow diagram. Fragility groups (F1–F2–F3) and inadvertent perioperative hypothermia (IPH).

Table 1

Basic characteristics.

Age (year)		74 ± 8 71 (66–96)
BMI (kg/m^2)		29.2 ± 5.1 29.0 (19.0–49.0)
Operation times (min)		74 ± 22 75 (35–131)
Anaesthesia times (min)		94 ± 26 90 (40–166)
Operation room temperature (ºC)		21.0 ± 1.2 21.0 (18.0–25.0)
Operation room humidity (%)		36 ± 9 34 (18–60)
Intravenous fluid volume (mL)		1226 ± 433 1200 (400–2600)
Surgery type, n (%)	Femur fracture	53 (15.6)
	Gonarthrosis	205 (60.5)
	Hip revision	81 (23.9)
Anesthesia type, n (%)	Spinal	251 (74.0)
	General	88 (26.0)
Sex, n (%)	Male	111 (32.7)
	Female	228 (67.3)
Fragility group, n (%)	Group F1 (1–3)	70 (20.6)
	Group F2 (4–7)	256 (75.5)
	Group F3 (8–9)	13 (3.8)
Age group, n (%)	Group A1 (66–74)	223 (65.8)
	Group A2 (75–84)	68 (20.1)
	Group A3 (85<)	48 (14.2)
ASA, n (%)	I	14 (4.1)
	II	133 (39.2)
	III	149 (44.0)
	IV	43 (12.7)

The data are presented as n (%), mean ± SD and median (min–max).
ASA = American Society of Anesthesiologists risk group, BMI = body mass index.

Table 2

Comparison of body temperature change (Δ_n) by minutes between fragility groups.

	Fragility groups			
	Group F1 (1–3)	Group F2 (4–7)	Group F3 (8–9)	P
Δ_{35} (ºC)	0.7 ± 0.4 0.6 (0.4–0.9)	0.8 ± 0.4 0.8 (0.5–1.2)	0.8 ± 0.5 0.7 (0.3–1.3)	.054*
Δ_{75} (ºC)	0.9 ± 0.5a 0.7 (0.6–1.3)	1.0 ± 0.4a 0.9 (0.7–1.3)	1.4 ± 0.3b 1.5 (1.3–1.5)	.010*

Δ_n: temperature change during surgery. Δ_n (ºC) = T_{pre} (ºC) – T_n (ºC). T_{pre}: temperature of before anesthesia induction (ºC). T_n: temperature of nth minutes on surgery (ºC).
Data are presented as mean ± SD and median (Q1–Q3).
Post Hoc tests (Tamhane): for variables with a different letter, the difference is statistically significant.
* Kruskal–Wallis test.

Table 3

Comparison of body temperature change (Δ_n) by minutes between age groups.

	Age groups			
	Group A1 (66–74)	Group A2 (75–84)	Group A3 (85<)	P
Δ_{35} (ºC)	0.8 ± 0.4 0.8 (0.4–1.1)	0.9 ± 0.5 0.9 (0.5–1.2)	0.8 ± 0.5 0.7 (0.3–1.3)	.145*
Δ_{75} (ºC)	0.9 ± 0.5 0.8 (0.6–1.3)	1.0 ± 0.5 1.1 (0.7–1.2)	1.0 ± 0.4 0.9 (0.5–1.5)	.304*

Δ_n: temperature change during surgery. Δ_n (ºC) = T_{pre} (ºC) – T_n (ºC). T_{pre}: temperature of before anesthesia induction (ºC). T_n: temperature of n^{th} minutes on surgery (ºC).
Data are presented as mean ± SD and median (Q1–Q3).
* Kruskal–Wallis test.

Table 4

Comparison of the incidence of IPH between fragility groups.

Fragility group	n (%)	Normothermia	Hypothermia	χ^2	P
Group F1 (1–3)	70 (20.6%)	37 (19.5%)	33 (22.1%)	1.211	0.546*
Group F2 (4–7)	256 (75.5%)	144 (75.8%)	112 (75.2%)		
Group F3 (8–9)	13 (3.8%)	9 (4.7%)	4 (2.7%)		
Total	339 (100.0%)	187 (100.0%)	149 (100.0%)		

IPH: inadvertent perioperative hypothermia. The data are presented as n (%).
* Pearson chi-square tests.

Table 5

Comparison of the incidence of IPH between age groups.

Age Group	n (%)	Normothermia	Hypothermia	χ^2	P
Group A1 (66–74)	223 (65.8%)	115 (60.5%)	108 (72.5%)	5.459	.065*
Group A2 (75–84)	68 (20.1%)	45 (23.7%)	23 (15.4%)		
Group A3 (85<)	48 (14.2%)	30 (15.8%)	18 (12.1%)		
Total	339 (100.0%)	190 (100.0%)	149 (100.0%)		

IPH = inadvertent perioperative hypothermia. The data are presented as n (%).
* Pearson chi-square tests.

1.371–1.778, $P < .001$)). In this study, all surgeries were evaluated nonselectively. Apart from age, they found that many cofactors were also at risk for IPH. In this prospective observational study, we evaluated only patients over 65 who underwent major surgery and examined the relationship between the development of IPH and the fragility and age groups of the patients.

In the study of Zhao et al, IPH risk factors were investigated in elderly patients undergoing total hip arthroplasty, and they found the hypothermia rate to be 51.67%.[5] Another study conducted on a similar patient group stated that hypothermia developed in one-third of the patients.[18] According to research by Zhao et al, age is one of the risk factors for IPH.[5] In this study, in which we evaluated elderly patients who underwent major orthopedic surgery, IPH developed in 44.0% of the patients. But in our study, unlike Zhao et al, we found no association between increasing age and the frequency of hypothermia.

Contrary to the known literature, in the research conducted by Yin et al, it was determined that patients aged >65 years did not pose a risk for hypothermia. However, this study only evaluated patients under general anesthesia, and did not focus on specific surgery.[19] Our study evaluated only major orthopedic surgery patients over 65 years of age. Similar to this study, we did not find a relationship between age and IPH frequency.

4.1. Limitation

Invasive or noninvasive methods can be selected according to the type of anesthesia and surgery for body temperature measurement. Noninvasive methods have their limitations in reflecting cor temperature. In patients under general anesthesia, the nasopharynx or esophagus is especially recommended for temperature monitoring. However, there is no standard method recommended for patients under spinal/epidural or local anesthesia.[20,21] In our clinic, sublingual membrane measurements are used in patients undergoing general anesthesia and tympanic membrane measurements are used in patients undergoing regional block. In current literature, many studies have been to identify risk factors for the occurrence of IPH. There are many identified risk factors that influence each other, so findings in these studies, such as ours, have diminishing evidence.[13]

Another limitation of our study was that only 13 (3.8%) of the included patients were in the severe fragility group. Unlike other fragility groups, femoral fracture and hip revision surgeries were frequently performed in patients in the severe fragility group.

In our study, we evaluated only patients over 65 years of age in a relatively homogeneous surgical group. Although there was no difference in short-term surgeries, we found that the decrease in body temperature was higher in patients in the severe fragility group in long-term surgeries. However, we did not find a similar relationship in terms of total IPH incidence. On the other hand, nearly half of our patients developed IPH. According to the research conclusion, in our clinic, regardless of the age or fragility groups of the patient, we should do closer temperature monitoring and take more precautions to ensure normothermia in the perioperative period.

5. Conclusion

Approximately half of underwent major orthopedic surgery patients over the age of 65 occurred IPH. There was no association between the fragility score and age, and the frequency of IPH.

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