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ORIGINAL STUDY

Incidence of hypothermia and factors affecting variation in core body temperature in patients undergoing arthroscopic surgery of the hip

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Perioperative hypothermia (below 36°C) has been associated with post-operative morbidity. The aim of this study was to determine the incidence of post-operative hypothermia in hip arthroscopy patients and factors affecting perioperative body temperature variation.

A prospective audit of 50 consecutive patients undergoing hip arthroscopy for a variety of pathologies was carried out. The final sample size was 46 due to missing data in 4 patients. Core body temperature was measured with a nasopharyngeal temperature probe at the induction of anaesthesia and at the end of the procedure. Other recorded variables were type of warming blanket, ambient theatre temperature and duration of surgery. It was noted whether the patient was shivering immediately post-operatively. The following demographic details were recorded : age, sex, body mass index and the American Society of Anaesthesiologists physical status score. The statistical analysis was performed with Stata® 12 (StataCorp LP, College Station, Texas) by use of a conditional regression model to calculate associations between post-operative body temperature and other variables.

The series included 30 female and 16 male patients aged 18 to 57 years (mean 35), with a mean BMI of 26.4 (standard deviation 4.2). Overall incidence of hypothermia below 36°C was 61%. Results of the conditional regression analysis suggested a positive association between post-operative body temperature and pre-operative body temperature (P< .001).

Incidence of hypothermia in hip arthroscopy patients is high (61%). We recommend warming patients pre-operatively with forced air warming devices to reduce this incidence.

Level of evidence : IV

Keywords : Peri-operative hypothermia ; Hypothermia ; Hip ; Arthroscopy ; Surgery

INTRODUCTION

Inadvertent perioperative hypothermia is defined by the National Institute for Health and Clinical Excellence (NICE) of the United Kingdom as a drop in the core body temperature of any patient to below 36°C, from one hour before induction of anaesthesia to 24 hours after entry into the recovery area *(9)*. It has a well-established association with post-operative

The authors declare that they have no conflict of interest. Ethical standards : All patients gave informed consent prior to being included in the study. All procedures involving human participants were in accordance with the 1964 Helsinki Declaration and its later amendments. The study was approved by the Research Ethics Committee.

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morbidity, including delayed wound healing, higher rates of infection, increased haemorrhage and more cardiovascular complications ; the standard of 36˚C being when these complications start to become clinically relevant *(12)*. Previous research looking at perioperative hypothermia in the context of arthroscopic surgery is limited. A search of the literature identified four papers, of which only one pertains to hypothermia in hip arthroscopy (Parodi et al) *(10)*. The other three, examining hypothermia in shoulder (Kim et al *(7)* ; Board et al *(3)*) and knee arthroscopy (Kelly et al *(6)*) have yielded controversial results regarding the effect of irrigation fluid temperature on core body temperature, demonstrating, if nothing else, the need for further study in this area. Parodi et al showed a low incidence of hypothermia in patients undergoing hip arthroscopy (2.7%), and statistically significant correlations between core body temperature and irrigation fluid temperature, core body temperature and diastolic blood pressure during surgery, and core body temperature and patient BMI. Furthermore, they described a significant inverse relationship between core body temperature and duration of surgery (beyond 120 minutes). Notably, Parodi et al set the definition of hypothermia as a core body temperature of 35˚C, 1˚C lower than the standard we used *(10)*.

Our prospective study aimed to record the incidence of hypothermia in patients undergoing hip arthroscopy, as an evaluation of our service provision. Our working hypothesis was that patients undergoing hip arthroscopy would be at risk of hypothermia below 36˚C. We further sought to determine the relationship between post-operative body temperature and certain measured variables, including pre-operative body temperature (after the induction of anaesthesia), surgery time, theatre temperature, patient gender, patient BMI and the type of intra-operative warming device used *(11)*.

MATERIAL AND METHODS

We prospectively audited a cohort of 50 consecutive patients who underwent hip arthroscopy at three hospitals in our region. The surgeon and anaesthetist for these cases were the same. If the patient requested an anxiolytic, premedication with 10-20 mg temazepam was given two hours prior to surgery. All patients underwent general anaesthesia. The anaesthesia was induced with intravenous propofol and fentanyl. A single dose of atracurium was given to facilitate endotracheal intubation. The anaesthesia was maintained with oxygen, air and desflurane. Intravenous morphine was given intra-operatively and post-operatively for pain relief, along with regular doses of paracetomol and voltarol.

Patients were advised to keep warm preoperatively but no forced air warming device was used before the induction of anaesthesia. Patients were warmed intra-operatively using one of two forced air warming devices. These were the 3M Bair Hugger™ Lower Body Model 52500 (used on the upper body) and the 3M™ Bair Hugger™ Therapy Surgical Access Blanket Model 570. Choice of device was according to availability at the institute at which a given procedure was performed.

Inclusion criteria were as follows : patients undergoing hip arthroscopy for a variety of pathologies (most commonly femoroacetabular impingement), operated on by the same surgeon, at one of the three medical institutions our practice covers. The only exclusion criterion was a patient being unfit for surgery.

Patients were positioned in the lateral decubitus position with the affected limb placed firstly in traction. The procedures were performed using the three-portal technique : one directly lateral paratrochanteric portal and another anterolateral paratrochanteric portal were used to access the central compartment of the hip. The peripheral compartment was accessed without traction, with the hip in flexion and abduction, by use of a third anterosuperior portal, and redirection of the anterolateral paratrochanteric portal.

Patient core body temperature was measured after induction of anaesthesia with a nasopharyngeal temperature probe (Covidien™ Mon-A-Therm™ General Purpose Temperature Probe 400™), and at the end of the procedure (before the patient had left the theatre) by the same method. The distance to which the probe was inserted was calculated by measuring the distance from the tip of the nose to

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the tragus. This ensured anatomically consistent positioning. Other recorded variables included type of warming blanket, ambient theatre temperature and duration of surgery (from entry into the anaesthetic room to leaving the theatre). No fluids were warmed. The physical sign of shivering was noted (if present immediately post-operatively). The following demographic details of the patients were recorded : age, sex, weight in kilogrammes, height in metres, body mass index (calculated from the previous) and the American Society of Anaesthesiologists physical status score.

Statistical Analysis

The statistical analysis was performed with Stata® 12 (StataCorp LP, College Station, Texas). The final sample size used in the analysis was 46, due to missing data in 4 patients. The association between post-operative temperature and pre-operative temperature, ambient theatre temperature, duration of surgery, patient BMI, blanket type and gender was examined using conditional regression analysis. The temperature post-operatively, regarded as the outcome variable, was regressed on these factors of interest. Fulfilment of statistical assumptions was verified via visual inspection of residuals graphs.

RESULTS

In our series of patients, 30 were female (65%) and 16 male (35%). Table 1 describes the patient cohort and key measured continuous variables. In terms of forced air warming, 18 patients were warmed by use of a surgical access blanket (39%) and 28 patients were warmed by a blanket covering the upper body only (61%).

Overall incidence of hypothermia below 36.0°C in this cohort of patients was 28 out of 46 patients (61%). Incidence of hypothermia below 35.0°C was 4 out of 46 patients (9%). 9 out of 46 patients (20%) were shivering post operatively. No significant difference was found between post-operative body temperature in patients who were observed to be shivering, as compared to those who were not (T-test, P= 0.84). However, the power to detect differences in temperature between the shivering and non-shivering groups was very low (α= 0.05, β= 0.94).

Results of the conditional regression analysis suggested a positive association between post-

Table 1 — Description of patient demographics and key measured continuous variables

(n=46)	Mean	SD	Range
Age (years)	35.0	10.8	18.0 to 57.0
BMI	26.4	4.2	17.0 to 35.2
Pre-operative temperature (°C)	36.0	0.5	34.7 to 37.0
Post-operative temperature (°C)	35.7	0.5	34.4 to 36.6
Theatre temperature (°C)	21.6	1.4	19.3 to 25.1
Duration of surgery (hh:mm)	01:22	00:22	00:50 to 02:45

SD = Standard deviation

Table 2 — Results from the conditional regression analysis of post-operative temperature in patients undergoing hip arthroscopy, as a function of variables

	Coefficient	**SE**	**P Value**
Pre-operative body temperature	.782	.010	< .001
Theatre temperature	.072	.039	.072
Duration of surgery	-.213	.155	.176
Patient BMI	-.0169	.010	.115
Blanket type (upper body)	-.140	.106	.193
Gender (male)	-.455	.119	.704

SE = Standard error

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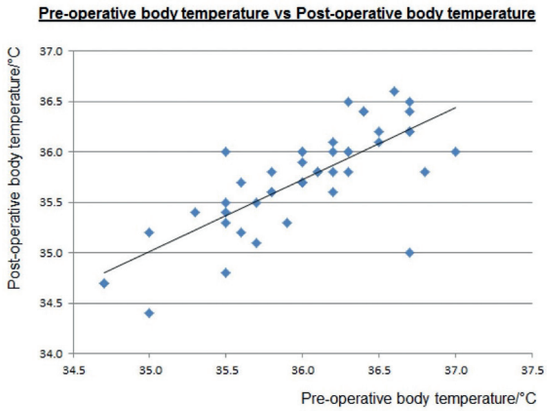

Figure 1. — Conditional regression analysis between post-operative body temperature and pre-operative body temperature

operative body temperature and pre-operative body temperature (P< .001). This association is demonstrated graphically (Figure 1). No other statistically significant associations were identified in the other factors that we evaluated (Table 2).

DISCUSSION

NICE has defined inadvertent perioperative hypothermia as a perioperative core body temperature of less than 36˚C *(9)*. Our audit found that at the end of surgery 61% of patients had a core temperature below 36˚C, which reflects a high proportion of patients falling outside best-practice guidelines. In comparison with the findings of Parodi et al *(10)*, this large result can be partly explained by the difference in standards used to define hypothermia. However, even when using the standard of 35˚C, we found that 4 out of 46 patients (9%) in our series were hypothermic post-operatively, which is an unacceptably high number to be at a temperature more than 1˚C below clinically relevant perioperative hypothermia. We sought to examine factors which may influence this.

After the induction of anaesthesia, the core body temperature decreases due to transfer of heat from the core to the peripheries due to anaesthesia-induced vasodilatation. Cold peripheries result in a greater transfer of heat at this point and thus a greater drop in core temperature. In our study 18 patients had a core temperature of less than 36˚C immediately after induction of anaesthesia. These patients, among others, became increasingly cold during the course of surgery (P <0.001). This makes a good case for pre-warming patients prior to induction of anaesthesia. Pre-warming increases the temperature of the peripheries ; this will result in a less marked decrease in core temperature on induction of anaesthesia. Forced air pre-warming of surgical patients has been demonstrated to be effective in other types of surgery *(1)*.

There are arguments for and against using warmed fluids as a means of reducing the incidence of perioperative hypothermia. It has been shown that use of radiofrequency probes in arthroscopic surgery causes an increase in intra-articular temperature both in vivo *(2,4)* and in cadaveric models *(5,8,13)*. In shoulder arthroscopy, room temperature irrigation fluid has been shown to reach a mean temperature of 27.8˚C, and a maximum of 41.8˚C *(10)*. If room temperature fluid can reach an intra-articular temperature of 41.8˚C, it is conceivable that any warming of this fluid before its use for irrigation could result in an intra-articular temperature of greater than 45˚C, considered to be the safe limit before tissue damage ensues *(2)*.

Our data did not demonstrate any significant association between post-operative temperature and any of the following variables : surgery time, theatre temperature, patient gender, patient BMI or type of intra-operative warming device used. Only 4 patients out of 46 (less than 10%) had a total surgery time of greater than 120 minutes (found by Parodi et al. *(10)* to be when surgery time became significantly associated with hypothermia) which is probably too small a sample size to demonstrate a meaningful association. Incidence of hypothermia with use of the surgical access warming blanket was lower than with upper body warming only, though this was not statistically significant. A study comparing these warming methods with a larger sample size would be warranted.

Symptoms and physical signs of early hypothermia did not appear to be affected by the absolute value of core body temperature. However, given that it is difficult to predict the temperature threshold of a given patient for feeling cold or shivering, all patients should be warned of this possibility in the pre-operative consultation.

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We identified three major limitations to our study. Firstly, our series included a small sample of patients. Secondly, the operations were performed at three different institutions, which adds a degree of challenge to the standardisation of practice across all patients studied. Thirdly, patients becoming hypothermic post-operatively were not followed up to assess for complications resulting from this. The third point is particularly pertinent as it determines the extent to which we should be concerned about perioperative hypothermia in our hip arthroscopy patients.

Incidence of hypothermia below 36°C in patients undergoing hip arthroscopy is high (61%). The patients undergoing hip arthroscopy should be warned of this preoperatively and all measures should be taken to reduce the incidence of it. To that effect, we recommend the pre-operative warming of patients with the use of forced air warming devices, which will minimise heat loss on induction of anaesthesia.

REFERENCES

1. **Andrzejowski J, Hoyle J, Eapen G, Turnbull D.** Effect of prewarming on post-induction core temperature and the incidence of inadvertent perioperative hypothermia in patients undergoing general anaesthesia. *Br J Anaesth.* 2008 ; 101 : 627-31.
2. **Barker SL, Johnstone AJ, Kumar K.** In vivo temperature measurement in the subacromial bursa during arthroscopic subacromial decompression. *J Shoulder Elbow Surg.* 2012 ; 21 : 804-7.
3. **Board TN, Srinivasan MS.** The effect of irrigation fluid temperature on core body temperature in arthroscopic shoulder surgery. *Arch Orthop Trauma Surg.* 2008 ; 128 : 531-33.
4. **Davies H, Wynn-Jones H, De Smet T, Johnson P, Sampath S, Sjolin S.** Fluid temperatures during arthroscopic subacromial decompression using a radiofrequency probe. *Acta Orthop Belg.* 2009 ; 75 : 153-7.
5. **Good CR, Shindle MK, Griffith MH, Wanich T, Warren RF.** Effect of radiofrequency energy on glenohumeral fluid temperature during shoulder arthroscopy. *J Bone Joint Surg Am.* 2009 ; 91 : 429-34.
6. **Kelly JA, Doughty JK, Hasselbeck AN, Vacchiano CA.** The effect of arthroscopic irrigation fluid warming on body temperature. *J Perianesth Nurs.* 2000 ; 15 : 245-252.
7. **Kim YS, Lee JY, Yang SC, Song JH, Koh HS, Park WK.** Comparative study of the influence of room-temperature and warmed fluid irrigation on body temperature in arthroscopic shoulder surgery. *Arthroscopy.* 2009 ; 25 : 24-29.
8. **McCormick F, Alpaugh K, Nwachukwu BU, Xu S, Martin SD** Effect of radiofrequency use on hip arthroscopy irrigation fluid temperature. *Arthroscopy* 2013 ; 29 : 336-42.
9. **National Institute for Health and Clinical Excellence** (2008) CG65 Perioperative hypothermia (inadvertent) : NICE guideline. Available at : http ://www.nice.org.uk/nicemedia/live/11962/40432/40432.pdf. Accessed 5 April 2016.
10. **Parodi D, Tobar C, Valderrama J, *et al*** Hip arthroscopy and hypothermia. *Arthroscopy.* 2012 ; 28 : 924-8.
11. **Sardesai A, Hujazi I, Khanduja V.** Surgical access warming blanket to prevent hypothermia after hip arthroscopy. *Arthroscopy.* 2012 ; 28 : 1045-6.
12. **Torossian A.** Thermal management during anaesthesia and thermoregulation standards for the prevention of inadvertent perioperative hypothermia. *Best Pract Clin Anaesthesiol.* 2008 ; 22 : 659-68.
13. **Zoric BB, Horn N, Braun S, Millett PJ. F**actors influencing intra-articular fluid temperature profiles with radiofrequency ablation. *J Bone Joint Surg Am.* 2009 ; 91 : 2448-54.

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