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# Barbed sutures versus staples for closure in total hip arthroplasty using wound ooze as a primary outcome measure: A prospective study

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Thomas D Knapper<sup>1,2</sup> , Mark Dahill<sup>1</sup>, Stephen Eastaugh-Waring<sup>1</sup>,  
Richard P Baker<sup>1</sup>, Jason CJ Webb<sup>2</sup>, Ashley W Blom<sup>3,4</sup>  
and Michael R Whitehouse<sup>3,4</sup>

## Abstract

**Background:** Prosthetic joint infection is a rare, but devastating complication of primary total hip arthroplasty (THA). Postoperative wound discharge and deep infection are related. We examined whether barbed sutures were associated with a decrease in the incidence of postoperative wound discharge when compared with skin closure using metal staples. **Methods:** Prospective nonrandomized comparison between two groups (35 barbed suture closures vs. 49 staple closures). Wounds were assessed daily for postoperative wound discharge until dry. Hemoglobin and hematocrit were recorded at the preoperative assessment and on day 3 postoperative. **Results:** There were no significant differences between the groups with regard to age, body mass index, gender, preoperative hemoglobin, preoperative hematocrit, or estimated blood volume. The number of days elapsed until the wound was dry was significantly lower in the barbed suture group than the staples group ( $p < 0.0001$ ). In the staples cohort, ongoing wound ooze resulted in delayed hospital discharge in three (6%) patients, six bed days total. **Conclusion:** Barbed sutures reliably reduce the period of postoperative wound ooze following primary THA compared to staple closure. The use of barbed sutures may prevent delayed patient discharge from hospital, decreasing the bed burden.

## Keywords

barbed suture, infection, staples, total hip arthroplasty, wound closure, wound discharge

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## Introduction

Total hip arthroplasty (THA) is associated with high patient satisfaction and is a cost-effective treatment.<sup>1</sup> A combination of expanding indications for THA, an ageing population and increased incidence of osteoarthritis, has increased demand. Postoperative wound complications, including prolonged ooze, wound dehiscence, or infection, contribute to a longer inpatient stay and increased risk of readmission.<sup>2–4</sup> Surgical site infections, in particular prosthetic joint infections (PJIs), are devastating complications with a profound impact on all aspects of patients' lives.<sup>5</sup> PJI is associated with significant morbidity and financial costs.<sup>6</sup>

<sup>1</sup> Department of Trauma and Orthopaedics, Southmead Hospital, North Bristol Trust, Bristol, UK

<sup>2</sup> Department of Trauma and Orthopaedics, Gloucestershire Royal Hospital, Gloucester, UK

<sup>3</sup> Musculoskeletal Research Unit, Translational Health Sciences, Bristol Medical School, Southmead Hospital, Bristol, UK

<sup>4</sup> National Institute for Health Research Bristol Biomedical Research Centre, University Hospitals Bristol NHS Foundation Trust and University of Bristol, Bristol, UK

### Corresponding author:

Thomas D Knapper, Gloucestershire Royal Hospital, Great Western Road, Gloucester GL1 3NN, UK.  
Email: thomas.knapper@nhs.net



There is an association between prolonged wound ooze and postoperative infection and between superficial wound infection and subsequent risk of PJI.<sup>2,7-10</sup> Satisfactory wound closure is an integral part of the intervention in THA and aids wound healing and the prevention of PJI. Methods of skin closure for THA include staples, interrupted non-absorbable sutures, or an absorbable subcuticular suture. Closure can then be augmented with either steri-strips or tissue glue. Choice of closure technique depends on a surgeon's experience, speed of technique, patient factors, and cost. Regardless of which method is favoured, effective wound closure requires a tension-free repair with everted edges that can withstand the movement required for rehabilitation.<sup>11,12</sup>

A recent advance in suture technology has been the introduction of barbed bioabsorbable sutures. The barbed properties of these sutures have been said to offer an even distribution of tension along the wound, knotless closure, shorter wound closure time, and cosmetic benefits.<sup>13</sup> Recent literature has also identified additional safety benefits, such as a reduction in the incidence of needlestick injuries secondary to the technique decreasing handling of the needle.<sup>14</sup> These published benefits have led to their frequent use in plastic and breast surgery.<sup>15</sup> Within orthopaedics, the majority of studies relate to the use of barbed sutures for closure of knee arthroplasty wounds. However, there remains a paucity of studies and evidence in general and for THA in particular.

Through this study, we compare the incidence in postoperative wound ooze and delayed discharge between wounds closed with staples and those with an absorbable barbed suture. Secondary outcomes of interest included immediate wound complications and hematological markers of blood loss. Our null hypothesis was that patients undergoing wound closure with a barbed suture for primary THA will have no reduction in duration of wound ooze or ooze affecting patient discharge compared to patients receiving staples.

## Materials and methods

We performed a prospective study involving two cohorts of patients undergoing primary THA over the same 6-month time period in our unit. All patients admitted for primary THA under the care of five fellowship-trained consultant hip surgeons were eligible for inclusion. Any patient undergoing revision hip surgery or THA for trauma was excluded. All operations were performed through the posterior approach with a departmental standard closure in layers using absorbable sutures for deeper tissues (capsule, external rotators, fascia, and deep dermal). The skin was then either closed using staples or a Quill, absorbable subcuticular barbed suture (Angiotech, Vancouver, Canada). Closure technique was as per the surgeon's standard practice. Two of the surgeons' preferences were for staples

(staple closure group) and three for Quill closure (barbed suture closure group).

Postoperative care was uniform with all patients receiving chemical venous thromboembolic prophylaxis; either with aspirin, clopidogrel, Clexane, or with a novel oral anticoagulant (NOAC). Hemoglobin and hematocrit were measured preoperatively and on day 3 postoperatively. Incisional wounds were reviewed daily until discharge. Time in days till the wound was dry if ongoing ooze was delaying discharge (in days), as well as any complications were recorded and evaluated. Patient demographics including gender, age, and body mass index (BMI) were recorded.

## Statistical methods

Statistical calculations were performed using GraphPad InStat and Prism (GraphPad Software Inc, La Jolla, California, USA). Significance was determined when  $p < 0.05$ . Data were tested for normality with a D'Agostino-Pearson omnibus normality test. When the data were normally distributed, data are described with the mean and standard deviation and parametric tests were used to compare the cohorts (two-tailed unpaired  $t$ -test). If the data were not normally distributed, data are described with the median and interquartile range (IQR) (the minimum and maximum are given when the median and IQR were identical between the groups) and nonparametric tests were used (Mann-Whitney  $U$  test). Categorical data were compared with a  $\chi^2$  test or a Fischer's Exact test when the numbers fell below 5 in a subgroup.

In order to calculate perioperative blood loss, estimated blood volume (EBV) was calculated according to the method of Nadler:<sup>16</sup>

$$\text{Male EBV(L)} = 0.3669 \times \text{height(m)}^3 + 0.03219 \times \text{weight(kg)} + 0.6041$$

$$\text{Female EBV(L)} = 0.3561 \times \text{height(m)}^3 + 0.03308 \times \text{weight(kg)} + 0.1833$$

Total perioperative blood loss was then calculated according to the method of Gross:<sup>17</sup>

$$\text{Total blood loss(mL)} = \text{EBV(L)} \times \frac{(\text{Hct}_{\text{pre}} - \text{Hct}_{\text{post}})}{\text{Hct}_{\text{ave}}} \times 1000$$

where  $\text{Hct}_{\text{pre}}$  is the preoperative hematocrit,  $\text{Hct}_{\text{post}}$  is the hematocrit on postoperative day 3, and  $\text{Hct}_{\text{ave}}$  is the average of  $\text{Hct}_{\text{pre}}$  and  $\text{Hct}_{\text{post}}$ .

Multiple regression analysis was performed on cases with complete data with the number of days until the wound was dry, whether there was delayed discharge due to the wound and the number of days of the delayed discharge as dependent variables. The independent variables used were the type of wound closure used, patient age,

**Table 1.** Comparison of group demographics, blood tests, blood loss, VTE prophylaxis, days to dryness, incidence of delayed discharge, and number of days of delayed discharge.

	Staple closure	Barbed suture closure	<i>p</i> Value
<i>n</i>	49	35	
Mean age (SD)	69 (12.1)	71 (12.0)	0.524
Mean BMI (SD)	31 (6.9)	31 (7.3)	0.833
Gender	Male = 16 Female = 33	Male = 13 Female = 22	0.670
Mean preoperative hemoglobin (SD)	136 (125–140)	135 (123–144)	0.742
Mean preoperative hematocrit (SD)	0.40 (0.04)	0.40 (0.04)	0.714
Mean day 3 postoperative hematocrit (SD)	0.30 (0.03)	0.32 (0.04)	0.012
Median estimated blood volume (IQR)	4.76 L (3.85 – 5.52)	4.30 L (3.80 – 5.51)	0.434
Median total perioperative blood loss (IQR)	1283 mL (847–2087)	851 mL (716–1157)	0.006
VTE prophylaxis	Aspirin Clexane Clopidogrel NOAC	8 15 0 12	
Median days to dryness (IQR)	1 (1–2)	0 (0–0)	<0.0001
Delayed discharge	Yes No	0 35	0.262
Median days delayed discharge (IQR, min–max)	0 (0–0; 0–2)	0 (0–0; 0–0)	0.142

VTE: venous thromboembolism; SD: standard deviation; BMI: body mass index; IQR: interquartile range; NOAC: novel oral anticoagulant.

BMI, gender, preoperative hemoglobin, blood loss (mL), and type of chemical thromboprophylaxis. There was multicollinearity observed ( $R^2 > 90$ ) in the models between BMI, height, and weight and between the preoperative hemoglobin and preoperative hematocrit. BMI and preoperative hemoglobin were, therefore, selected for the models.

## Results

Eighty-eight patients undergoing primary THA were recruited; of which, 53 had their wound closed using staples and 35 by using barbed sutures. Four patients were excluded from the staples closure cohort due to incomplete data.

There were no significant differences between the groups when the age, BMI, gender, preoperative hemoglobin, preoperative hematocrit, or EBV were compared. In the staple closure group, 29 patients received Clexane, 17 aspirin, 1 NOAC, and 1 clopidogrel compared to 15 Clexane, 12 NOAC, and 8 aspirin in the barbed suture closure group (Table 1). There was a statistically significantly higher day 3 postoperative hematocrit in the barbed suture closure group when compared to the staple closure group ( $p = 0.012$ , difference in means 0.02). There was a statistically significantly lower total perioperative blood loss in the barbed suture closure group when compared to the staple closure group ( $p = 0.006$ , difference in means 432 mL).

The number of days elapsed until the wound was dry was significantly lower in the barbed suture closure group

than the staple closure group ( $p < 0.0001$ ). In the staple closure group, there were three cases, in which discharge was delayed due to wound ooze. Each of these resulted in a delayed discharge of 2 days. In the barbed suture closure group, there were no cases of delayed discharge due to wound ooze ( $p = 0.262$ ).

The multiple regression model for days to dryness showed a significant relationship between the variables ( $p = 0.0086$ ). The only variable in the model that contributed significantly was the type of wound closure used ( $p = 0.0009$  in favour of the barbed suture closure group). The other variables did not contribute significantly ( $p = 0.16–0.53$ ). The model for whether there was delayed discharge showed no significant relationship ( $p = 0.37$ , individual variable  $p$  values 0.092–0.899) nor did the model for the number of days of delayed discharge ( $p = 0.37$ , individual variable  $p$  values 0.092–0.899).

## Discussion

This study has shown that the use of barbed sutures is associated with a shorter duration of postoperative wound ooze in primary THA. The normal wound healing process often involves a small amount of fluid ooze thought to be a by-product of hemolysis of subcutaneous blood.<sup>7</sup> Prolonged wound discharge is undesirable. Bannister et al. demonstrated that prolonged wound discharge lengthens hospital stay and is associated with an increase in surgical site infection.<sup>7</sup> Another study by Surin et al. also reported an association between early wound discharge and late PJI.<sup>2</sup> To our knowledge, this is the first study comparing

skin closure with a barbed suture versus staples in hip arthroplasty. Singh et al. and a meta-analysis by Kim et al. have shown barbed sutures to be superior to absorbable subcuticular sutures.<sup>4,18</sup> The advantage of a running closure in attaining a more “watertight closure” has been demonstrated in cadaveric knee arthrotomy models which were closed with either running barbed sutures or interrupted sutures.<sup>19</sup>

When looking at secondary hematological measures, we noted a statistically significant difference in estimated perioperative blood loss and drop in pre- to day 3 postoperative hematocrit between the cohorts. The larger volume of blood loss in the staples group is likely to be clinically significant but is unlikely to be related to wound closure alone. It is most likely explained by unmeasured confounding between the two cohorts.

The strengths of this study include the fact that the groups were closely matched for demographic features and underwent surgery over the same period using the same operative approaches and postoperative regimens in a single unit. Weaknesses of this study include the fact that patients were not randomized and thus selection bias and unmeasured confounding are likely. Our sample size was too small to identify a significant difference in our secondary outcome (delayed discharge due to ooze), and chemical anticoagulation administered was not standardized. Aquilina et al. demonstrated that NOACs are associated with a delay to wound dryness compared to aspirin.<sup>20</sup> Therefore, their increased use in the suture arm of the study would have been expected to increase the duration of wound ooze. This was not the case, therefore, we postulate that had anticoagulation been standardized between the two groups, the difference in mean days to dryness and delay in patient discharge may have been greater.

This work highlights the need for a randomized controlled trial of barbed sutures versus alternate closure methods assessing the outcomes reported here as well as longer term outcomes including wound breakdown, scar cosmesis, and incidence of deep PJI.

## Conclusion

The use of barbed subcuticular sutures is associated with a shorter duration of postoperative wound ooze compared to staples in the setting of primary THA and we recommend their use.

## Declaration of conflicting interests

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## ORCID iD

Thomas D Knapper  <https://orcid.org/0000-0003-0408-1189>

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