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# Preparing the femur before the acetabulum does not reduce total blood loss in primary total hip replacement

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**Abstract:**

**Introduction:**

Total hip replacement is a common and effective surgical intervention for patients with debilitating joint pain but it does represent a significant surgical intervention. For such interventions, blood loss is a potential cause of morbidity and mortality. Optimisation of surgical interventions focuses on reducing such risks. The aim of this study was to determine whether the order of surgical steps, preparing the femur before or after the acetabulum, was associated with the amount of total blood loss in total hip replacement.

**Methods:**

We performed a retrospective study of 100 patients undergoing primary total hip replacement between 2014 and 2018. This was a before and after (interrupted time series) study around the introduction of femur first preparation for total hip replacement in our unit. Fifty patients underwent a standard femoral preparation after placement of the acetabular component. The second 50 patients had the femoral canal prepared and broached prior to the acetabular component. Estimated blood volume and total blood loss associated with the perioperative period were calculated for each patient and a multiple regression analysis performed to account for other patient and surgical variables associated with perioperative blood loss.

**Results:**

There was a small reduction in total blood loss for the group who underwent femoral preparation prior to acetabular preparation with a mean difference of 39mls. This difference however was not clinically or statistically ($p=0.392$) significant. Gender ($p<0.0001$), Body Mass Index (BMI; $p<0.0001$), preoperative haematocrit ($p<0.0001$),

postoperative haematocrit ($p<0.0001$) and age ($p=0.004$) were the only factors significantly associated with the total volume of blood loss.

**Conclusions:**

Whether the femur was prepared before or after the acetabulum did not significantly predict the total volume of blood loss for primary total hip replacement.

## Introduction:

The complications of total hip replacement (THR) are well documented [1]. THR has a reported mean total blood loss of 1,510 mL, with a calculated hidden loss of 471 mL [2]. Blood loss and symptoms of anaemia may necessitate the need for blood transfusion which carries additional risk and is associated with increased hospital length of stay, increased morbidity (including infection), poorer postoperative outcomes and increased mortality [3-7].

Ideally, patients undergoing THR will undergo haematology screening and haemoglobin optimisation preoperatively [8]. Surgical teams will employ blood loss reduction techniques and post-operative protocols to reduce total blood loss and the need for transfusion. Techniques which have led to a decrease in total blood loss include the use of cautery, tranexamic acid, maintenance of normal body temperature, improved dissection and shorter operating times [5].

While haemostasis of the soft tissue is achievable intra-operatively, blood loss from cut bone surfaces following femoral preparation and acetabular reaming is often not achieved until placement of the implant rendering a tamponade effect. The senior author (RB) was performing a THR for an osteoarthritic hip in an achrondroplasic patient. Concerns about the small femur led to a pre-operative plan to prepare the femoral canal first – this proved to be as straightforward as preparing a THR in the conventional fashion. Since this date the senior author has always prepared the femur first when using a modular femoral broaching system for THR.

We hypothesised that an appropriately sized femoral broach placed soon after the femoral neck is resected will tamponade femoral bleeding expeditiously, leading to a reduced bleeding time, which may translate to a reduction in total blood loss. To further our understanding of intra-operative blood loss in THR, we compared cases of THR where the femoral broach was inserted before and after acetabular preparation.

## Methods

One hundred consecutive patients who underwent primary THR at a tertiary elective Orthopaedic unit between 2014 and 2018 were included. Of the 100 patients included, 50 underwent femoral canal preparation and femoral tamponade with the final broach before acetabular preparation and 50 underwent acetabular preparation prior to femoral canal preparation. Both cohorts of patients were consecutive.

The primary outcome measure for the two arms of this study was total blood loss. The estimated blood volume for each patient was calculated according the method of Nadler et al. [9]. Here the blood volume is calculated by the formula:

Estimated blood volume=k1*height(m)+k2*weight(kg)+k3

For males, k1=0.3669, k2=0.03219 and k3=0.6041. For females, k1=0.3561, k2=0.03308 and k3=0.1833. Total blood loss associated with the total hip replacement procedure and accounting for hidden blood loss was calculated according to the formula of Gross et al. [10] as described by Liu et al. [11] where:

Total blood loss=Estimated blood volume ((Hct preop-Hct postop))/((Hct preop+Hct postop)/2)

This is a single centre, two surgeon before and after comparison study, otherwise described as an interrupted time series. The inclusion criteria were patients undergoing primary total hip joint replacement. The exclusion criteria were patients undergoing primary surgery with a non-modular broaching system, revision surgery, complex primary arthroplasty requiring bone graft, osteotomy or revision implants.

**Procedure:** All THRs were performed under the care and supervision of the senior authors (MRW and RB) through a posterior approach with haemostasis achieved during the approach. Tranexamic acid was routinely given at induction (1g IV) with no exclusions. The THR prostheses used were all DePuy Synthes (Warsaw, IN, USA: C stem AMT or Corail stems and Ogee or Pinnacle acetabular components). The type of fixation (cemented, hybrid or uncemented) was at the discretion of the surgeon according to patient age, activity and bony anatomy. All wounds were closed in layers using the same technique with absorbable sutures. Skin closure was either with a barbed continuous suture or an absorbable monofilament suture.

**Femur First:** In the 'femur first' group, after the surgical approach, dislocation of the hip and femoral neck resection, the surgeon went on to prepare the canal with the use of sequential broaches. Once the appropriately sized broach was placed into the femur, it was left in situ and the femur retracted anteriorly to expose the acetabulum for preparation and insertion of definitive acetabular components. The THR was then trialled with modular neck and head on the femoral broach. Once trialling was complete the femoral side of the THR was completed. (This technique can be viewed at www.OrthOracle.com published 2/8/18)

**Femur Second:** In the 'femur second' group, following the femoral neck resection, the femur with raw bone surface was retraced anteriorly for exposure of the acetabulum. The acetabulum was prepared and the definitive cup placed. The femur was then prepared with the use of broaches in a standard fashion, trialled and then the definitive prosthesis implanted.

Further variables which could affect blood loss were collected; gender, Body Mass Index (BMI), age at intervention, American Society of Anaesthesiologists (ASA) grade,

THR fixation (cemented, hybrid, uncemented), use of anticoagulants preoperatively (aspirin, clopidogrel, novel anticoagulants or warfarin), preoperative haematocrit, postoperative haematocrit, and postoperative thromboprophylaxis (clexane, aspirin, clopidogrel, novel anticoagulants or warfarin)

**Statistical Methods**

Statistical calculations were performed using GraphPad InStat and Prism (GraphPad Software Inc, La Jolla, CA, USA). Data distribution was assessed with the Kolmogorov-Smirnov test, where data was normally distributed, it was described with the mean and standard deviation (SD), where it was not normally distributed, it was described with the median and interquartile range (IQR). Multiple regression analysis was performed on cases with complete data. The dependent variable was the total volume of blood loss (including hidden blood loss), the independent variables were whether the femur was prepared first (before the acetabulum), gender, Body Mass Index (BMI), age at intervention, American Society of Anaesthesiologists (ASA) grade, THR fixation (cemented, hybrid, uncemented), use of anticoagulants preoperatively (aspirin, clopidogrel, novel anticoagulants, warfarin), preoperative haematocrit, postoperative haematocrit, wound closure (barbed suture, monocryl) and postoperative thromboprophylaxis (clexane, aspirin, clopidogrel, novel anticoagulants, warfarin). The R2 values were inspected to determine if multicollinearity was a problem in the model, if the R2 value was >0.75 then the included values were rationalised. Significance was determined when $p < 0.05$.

**Results**

The mean blood loss was 965mls (SD 474). The mean blood loss when the femur was prepared first was 946mls (SD 500) and when the femur was prepared second was 985mls (SD 450). There was a reduction in total blood loss for the femur first group (mean of 39mls).

**Table 1.** Patient demographics

The multiple regression model for the total volume of blood loss (including hidden blood loss) showed a significant relationship ($p<0.0001$). Gender ($p<0.0001$), Body Mass Index (BMI; $p<0.0001$), preoperative haematocrit ($p<0.0001$), postoperative haematocrit ($p<0.0001$) and age ($p=0.004$) were the only factors significantly associated with the total volume of blood loss. Whether the femur was prepared before or after the acetabulum did not significantly predict the total volume of blood loss ($p=0.392$).

**Table 2.** Statistical outcomes

## Discussion

Techniques to reduce blood loss during arthroplasty surgery continue to be evaluated. There is now a considerable body of level 1 evidence supporting the use of tranexamic acid in arthroplasty surgery. Sukeik et al [12] conducting a systematic review and meta-analysis in 2011 which concluded that tranexamic acid significantly reduced intra-operative blood loss and transfusion requirements after primary THR. While tranexamic acid has been shown to be effective, novel approaches such as the use of a bipolar sealer (a device which functions to shrink the collagen in the walls of the tissue

vessels without causing charring and burning, as opposed to standard electrocautery) did not show significant reduction in the need for blood transfusions or significant reductions in overall blood loss [13]. We attempted to establish whether the order of surgical steps in standard THR could reduce total blood loss.

Our two patient groups were well matched in gender, age, BMI and ASA. There was a small reduction in total blood loss with the femur first technique with a mean difference of 39 mls. This mean difference did not however, reach statistical significance (p=0.392). Gender, Body Mass Index and age were all shown to be statistically influential factors in blood loss for THR. Increased BMI was correlated with increased blood loss in this cohort. The evidence to date on the association of BMI and blood loss with some studies agreeing with our findings [14] and others finding no association [15]. BMI may be amenable to optimisation prior to surgery but although it is acknowledged that risks of outcomes such as revision and mortality are associated with BMI, it has yet to be demonstrated that interventions to modify BMI prior to THR also modify these risks. Gender and age have also been reported as significant factors which effect total blood loss as reported by Miao et al. in 2015 with their review of hidden blood loss in 322 patients [14] but are not amenable to preoperative optimisation. Our findings regarding haematocrit are in support of other literature, which recommends haematocrit optimisation prior to hip replacement surgery [8,16-18].

Interestingly, the mean total blood loss from THR is lower in our cohort of 100 patients (965 mls) than the previous documented average total blood loss from Sehat et al. of 101 patients (1510 mls) [2]. Both groups of patients were operated on through the same tertiary elective orthopaedic centre with the first cohort being operated on in 1999-2001 and our cohort 2014-2018. In over a decade in the same institution, mean

total blood loss has decreased by over 500 mls. This difference is consistent with that observed by other authors on the introduction of tranexamic acid [19]. Continued research and development in this area may yet see further decreases in the mean total blood loss form THR and other major orthopaedic operations.

The main limitation of this study is the number of patients recruited. We performed an a priori power calculation which predicts that a study of 4664 patients would be required to show statistical significance between the two techniques due to the small effect size (0.082) shown in the difference between these two patient groups.

## Conclusion

Gender ($p<0.0001$), Body Mass Index (BMI; $p<0.0001$), preoperative haematocrit ($p<0.0001$), postoperative haematocrit ($p<0.0001$) and age ($p=0.004$) were factors significantly associated with the total volume of blood loss. Whether the femur was prepared before or after the acetabulum did not significantly predict the total volume of blood loss ($p=0.392$).

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Table 1: Patient Demographics

| | Femur Prepared First | Femur Prepared Second |
|---|---|---|
| Mean total blood loss mls (SD) | 946 (500) | 985 (450) |
| Gender (Male:Female) | 23:27 | 23:27 |
| Mean BMI (SD) | 29.3 (6.6) | 30.8 (6.7) |
| Median age (IQR) | 72 (66,81) | 68 (59,76) |
| Median ASA grade (IQR) | 2 (2,3) | 2 (2,3) |
| Mean preoperative haematocrit (SD) | 0.412 (0.041) | 0.415 (0.042) |
| Mean postoperative haematocrit (SD) | 0.337 (0.042) | 0.340 (0.043) |
| THR fixation (cemented:hybrid:uncemented) | 21:26:3 | 18:27:5 |
| Wound closure (barbed suture:monocryl) | 50:0 | 36:14 |

Table 2. Statistical outcomes

| | t ratio | p value | Significant |
|---|---|---|---|
| Femur first | 0.860 | 0.392 | No |
| Gender | 9.724 | <0.0001 | Yes |
| BMI | 6.472 | <0.0001 | Yes |
| Age | 2.939 | 0.004 | Yes |
| ASA grade | 0.177 | 0.860 | No |
| Preoperative haematocrit | 29.839 | <0.0001 | Yes |
| Postoperative haematocrit | 36.739 | <0.0001 | Yes |
| THR fixation | 0.958 | 0.341 | No |
| Preoperative anticoagulant | 0.630 | 0.530 | No |
| Wound closure | 0.608 | 0.545 | No |
| Postoperative thromboprophylaxis | 1.619 | 0.109 | No |