Original Article

Total hip arthroplasty in patients with haemophilia – What are the risks of bleeding in the immediate peri-operative period?

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ARTICLE INFO

Article history:

Received 4 May 2016

Accepted 24 June 2016

Available online 27 July 2016

Keywords:

Haemophilia
Hip Arthroplasty
Bleeding Risk
Transfusion

ABSTRACT

Background: Undergoing a major surgical intervention such as total hip arthroplasty (THA) with an underlying clotting disorder like haemophilia poses its own unique challenges. Despite the advances in factor replacement and medical management, the potential for excessive and uncontrolled haemorrhage still exists. The aim of this study was to quantify blood loss, peri-operative transfusion requirements and risk of haematoma formation in a cohort of patients with haemophilia undergoing THA.

Methods: All patients with haemophilia types A or B who had undergone THA in the previous 10 years were identified from the Hospital In-Patient Enquiry system and theatre logs. A comprehensive review of operative records, laboratory parameters and peri-operative haematological management was conducted.

Results: Eleven male patients (12 THA) were identified. The mean age was 56 years (range 28–76). The mean intra-operative blood loss was 502 ml (100–1250 ml) compared to an established normal blood loss of 400 ml. The mean drop in haemoglobin was 3.25 g/dl in 48 h. Only one patient required a post-operative transfusion of two units of red cell concentrate. There were no complications of haematoma formation.

Conclusion: The results in our institution compare favourably with the established blood loss reported in the literature and by assessment with International Guidelines. Average blood loss in patients with haemophilia was higher than the established normal, but there was no increased transfusion requirement.

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1. Introduction

Undertaking a major surgical intervention such as total joint arthroplasty (TJA) in patients with an underlying clotting disorder such as haemophilia poses unique challenges, despite advances in factor replacement and perioperative medical management.¹ Patients with haemophilia suffer recurrent atraumatic joint haemarthroses due to their coagulopathy. This in turn leads to chronic synovitis that can progress to symptomatic haemophilic arthropathy and symptomatic arthritis.^{3,2} Often these patients are younger, usually developing end-stage haemophilic arthropathy between the ages of 20–40.^{1,2} TJA is now an accepted treatment for symptomatic arthritis affecting the hip and knee, once other conservative treatments have been tried and failed.^{3,4}

The knee is the most common joint affected and by inference a total knee arthroplasty (TKA) is the most common arthroplasty procedure in patients with haemophilia.⁵ Much has been written about bleeding and complications for TKA with a risk of significant bleeding of up to 40% reported despite adequate factor replacement.^{6–9}

Symptomatic, end-stage haemophilic arthropathy affecting the hip is less common and therefore there is a paucity of published data on bleeding risks following total hip arthroplasty (THA). The first documented THA in a patient with haemophilia was performed in 1967 using cryoprecipitate to manage bleeding. It was reported “there was no undue haemorrhage, and no transfusion was required”.¹⁰ Many recent outcome studies have focused on medium to long-term outcomes – that is infection and revision rates, with no study focussing on the assessment of bleeding risk as a primary outcomes measure.^{2,11} Mann et al. reported an equivalent blood loss with routine THA for osteoarthritis.¹ However, others have shown an increased bleeding risk with a reported mean blood loss of 900 ml.¹² Nelson et al. reported the incidence of haematoma

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formation as high as 7.6% (3/39 patients).¹³ None of the available studies in the literature have evaluated a drop in haemoglobin in the peri-operative period as a measure of blood loss.

The aim of this study was to determine the risk of bleeding in the peri-operative period, including the risk of haematoma formation and the peri-operative blood transfusion requirements in a cohort of patients with haemophilia undergoing THA. Secondly we aimed to compare the results of our study to the available current published data.

2. Materials and methods

Ethical approval was obtained at the outset from the Hospital's Risk and Legal Department, which governs Hospital Clinical Audit and Internal Research.

This study was carried out at a national centre for coagulation disorders, which offers on-site specialised haematological and orthopaedic services. All patients with haemophilia (types A and B) who had undergone a THA in a 10-year period from September 2003 to May 2012 were identified from the HIPE (Hospital In-Patient Enquiry) database. The HIPE search output was cross-referenced with the theatre records to ensure accuracy, and to identify any additional patients. The inclusion criteria were any patient with haemophilia type A or B who had undergone a primary THA in the previous 10 years. Ten-year period was chosen as the cut off to reduce the variation in haematological practices in the peri-operative management over the study period. Exclusion criteria included bleeding disorder(s) other than haemophilia, children (age <18 years), revision hip replacement or other joint replacement.

Case notes were retrieved and reviewed to ascertain details of patient demographics – age, gender, haemophilia type and clinical type, inhibitor status and medical co-morbidities including HIV and hepatitis status. Haematological parameters were recorded from chart documentation and blood results on the Hospital EPR (Electronic Patient Record) system – details collected are shown in Table 1.

Intra-operative EBL is quantified by measuring irrigation fluid and blood in the calibrated suction container and weighing surgical gauzes used for blood and fluid collection during surgery. The known quantity of irrigation fluid is then subtracted from the total to give the estimated blood loss.

Our results were assessed using the International Guidelines from World Federation of Haemophilia (WHF), which objectively assesses outcomes in haemostasis by comparing blood loss in haemophilia to a normal/non-haemophiliac population (see Table 2).¹⁴ Normal blood loss following THA was defined as 400 ml as per literature review.^{25–27} As our hospital is a tertiary referral centre for patients with haematological conditions but otherwise conducts little elective orthopaedic surgery, as these cases are done in a separate institution, it was not possible to establish blood loss in a normal group of controls for comparison. The results of the study were analysed using the statistical package Minitab version 14.0[®]. For both the one tailed *t*-test and Pearson's

Table 2

Definitions of adequacy of haemostasis for surgical procedures.¹⁴

Excellent	Intra-operative and post-operative blood loss similar (within 10%) to the non-haemophilic patient. <ul style="list-style-type: none"> • No extra (unplanned) doses of FVIII/FIX/bypassing agents needed AND • Blood component transfusions required are similar to non-haemophilic patient
Good	Intra-operative and/or post-operative blood loss slightly increased over expectation for the non-haemophilic patient (between 10 and 25% of expected), but the difference is judged by the involved surgeon/anaesthetist to be clinically insignificant. <ul style="list-style-type: none"> • No extra (unplanned) doses of FVIII/FIX/bypassing agents needed AND • Blood component transfusions required are similar to non-haemophilic patient
Fair	Intra-operative and/or post-operative blood loss increased over expectation (25–50%) for the non-haemophilic patient and additional treatment is needed. <ul style="list-style-type: none"> • Extra (unplanned) dose of FVIII/FIX/bypassing agents needed OR • Increased blood component (within 2-fold) of the anticipated transfusion requirement
Poor	Significant intra-operative and/or post-operative blood loss that is substantially increased over expectation (>50%) for the non-haemophilic patient, requires intervention, and is not explained by a surgical/medical issue other than haemophilia <ul style="list-style-type: none"> • Unexpected hypotension or unexpected transfer to IC due to bleeding OR • Substantially increased blood component (>2-fold) of the anticipated transfusion requirement

coefficient a *p*-value of <0.05 was accepted as signalling statistical significance.

3. Results

Twenty-two patients were identified from the initial search and 21 of these charts were obtained (95%) with the final chart reported permanently lost. Ten patients (48%) were excluded from the study, as they did not meet the inclusion criteria leaving 11 patients for analysis. One patient with haemophilia had undergone a revision total hip replacement, and another patient had a hemiarthroplasty for treatment of avascular necrosis of the hip. Eight patients had a clotting disorder other than haemophilia: Factor X deficiency (1); Factor XI deficiency (3); von Willebrand's disease (2); platelet dysfunction (1), and unknown coagulopathy (1).

One patient had bilateral THR at a 2-year interval, which gave data for 12 THA in total. This patient's data was recorded for each event and he was identified as 6R and 6L for each episode. To avoid confusion no identifier of "patient 7" was applied. The results and demographics for each patient are recorded and presented in Table 3 and surgical details in Table 4. The mean age for the group was 56 years (range 28–76, SD ± 15.6). All patients were male. Haemophilia A was the diagnosis in 9 of the 11 cases (5 severe; 1 moderate; 3 mild). Two patients had haemophilia B (both severe). Six of the 11 cases were hepatitis C positive and one was HIV positive. No patient had factor inhibitors pre-operatively or any other medical co-morbidity which would affect coagulation.

Haematological management was standardised according to the NCHCD Haemostasis Guidelines.¹⁵ A bolus infusion of recombinant factor was administered to bring the factor level up to 100% (1.0 IU/ml) – Advate[®] for Factor VIII deficiency or BeneFix[®] for Factor IX. This was given 60 min prior to surgery and factor levels tested 20 min after infusion. A continuous infusion continued peri-operatively for 5 days for patients with severe clinical type, with rate adjusted according to the daily factor level. Bolus dosage thereafter was administered as required by the attending haematologist. Perioperative factor levels were adequate in all cases. Two consultant surgeons were the primary operator in

Table 1

Haematologic details collected from medical records.

Pre-operative haemoglobin and factor levels
Haematological factor replacement
Estimated intra-operative blood loss (EBL)
Use of post-operative drain and the documented blood loss into the collection bottle
Post-operative haemoglobin levels
Peri-operative transfusion requirements
Incidence of post-operative haematoma formation

Table 3
Patient demographics.

Patient	Age	Sex	Haemophilia	Type	Medical co-morbidity	Inhibitors
1	69	M	A	Severe	Hep C +ve	N
2	63	M	A	Mild	Angina, CABG	N
3	28	M	A	Severe	Hep C +ve	N
4	74	M	B	Severe		N
5	41	M	A	Moderate	Hep C +ve	N
6L	67	M	A	Severe		N
6R	65	M				N
8	76	M	A	Mild		N
9	56	M	A	Mild		N
10	45	M	A	Severe	Hep C +ve, HIV +ve	N
11	37	M	B	Severe	Hep C +ve	N
12	49	M	A	Severe	Hep C +ve, liver fibrosis, bilateral TKR, Bilroth gastrectomy	N

Table 4
Surgical details.

Patient	Date of surgery	Side	Implant	Surgeon	Drain used	Drain output
1	September 12	Right	Uncemented	TM	N	–
2	July 11	Left	Uncemented	TM	N	–
3	April 10	Right	Uncemented	TM	N	–
4	May 12	Right	Uncemented	TM	N	–
5	April 12	Right	Uncemented	TM	N	–
6L	January 09	Left	Cemented Charnley	HS	Y	680
6R	October 07	Right	Cemented Charnley	HS	Y	400
8	September 10	Right	Cemented Charnley	HS	N	–
9	November 10	Right	Cemented Charnley	HS	Y	675
10	November 08	Left	Cemented Charnley	HS	Y	30
11	September 03	Right	Cemented Charnley	HS	Y	950
12	November 08	Left	Cemented Charnley	HS	Y	0

5/12 and 7/12 cases respectively. TMCC does not routinely use surgical drains whereas HS uses them in almost all cases – hence the difference in treatment. Where a drain was sited – the total output at removal (48 h following surgery) was recorded. As only half of the patients in this study had a drain sited, the output amount was not used in the calculation of surgical blood loss as it would have elevated the EBL for the patients with drains and falsely elevated the mean results. Therefore the data for estimated blood loss is “intra-operative blood loss”, and is presented as such. The mean drain output for the six patients with a drain was 456 ml (SD $\pm$ 383 ml).

Haemoglobin data is presented in Table 5. No patient required an intra-operative transfusion and there were no documented complications of haematoma formation. The mean blood loss (EBL) for the group was 502 ml (range 100–1250 ml, SD). Patient 6 who had sequential bilateral THA had a recording of “minimal” blood loss in his theatre record for the right side, whereas the data for EBL

on the left side was not recorded in the theatre record, the surgeon's operative note or the anaesthetic note. Therefore the mean EBL was calculated from the 10 available numerical measures. It is possible that this mean value would be lower, if patient 6R EBL value was known and had been included in the calculation. The difference in EBL compared to the normal value of 400 ml was not statistically significant ($p = 0.377$; one tailed t -test).

The mean change in haemoglobin was 3.25 g/dl (range 1.9–5.1 g/dl) over 48 h. Only one patient (patient 9) required a blood transfusion. His haemoglobin dropped to 7.8 g/dl in the 24-h period post-operatively and he was symptomatically hypotensive. His EBL was 600 ml. He required two units of RCC and his clinical and haematological condition improved. Patient 11 lost 1250 ml intra-operatively but did not require a blood transfusion and was haemodynamically stable throughout the peri-operative course. He also had a recorded output of 950 ml total in his surgical drains

Table 5
Blood loss and haematological parameters.

Patient	Pre-operative factor level	Intra-operative EBL ^a (ml)	Pre-op Hb (g/dl)	Post-op Hb 24 h (g/dl)	Post-op Hb 48 h (g/dl)	Change Hb 48 h (g/dl)	Transfusion
1	1.2	750	10.8	8.4	8	–2.8	N
2	1.15	550	13.2	11	10.7	–2.5	N
3	0.99	600	14.6	10.1	9.5	–5.1	N
4	1.06	200	13.3	11.9	11.4	–1.9	N
5	0.96	200	12.1	11	–	–	N
6L	1.45	“Minimal”	15.9	13.3	11.7	–4.2	N
6R	1.52	Not record	15.5	13	12.6	–2.9	N
8	1.2	200	14.2	13	11.5	–2.7	N
9	1.43	600	15	13.1	11.1	–3.9	N
10	0.82	570	13.5	7.8	9.1	–4.4	Y 2 units
11	1.47	1250	13.4	12.3	10.3	–3.1	N
12	1.2	100	14.3	11.9	12	–2.3	N
Mean	1.2	502 [*]	13.7	11.4	10.7	–3.25	

^a EBL, estimated blood loss.

^{*} p value = 0.377 compared to normal blood loss 400 ml.

Table 6

Results of adequacy of haemostasis using WHR guidelines.

	Study patients	Löfqvist data
Excellent	<i>n</i> = 5	<i>n</i> = 4
Good	<i>n</i> = 6	<i>n</i> = 2
Fair	<i>n</i> = 0	<i>n</i> = 4
Poor	<i>n</i> = 0	<i>n</i> = 0
Total	11 ^a	10 ^b

^a No data for patient 6L.^b Two patients data excluded due to co-founders.

at 48-h which puts his total estimated loss at 2200 ml. Given that his haemoglobin levels only dropped by 2.3 g/dl – it is possible that there was an error in the initial EBL assessment. If the total amount of irrigation fluid used was not accounted this could give a falsely high EBL. There was no statistically significant correlation between EBL and change in Hb at 48 h in this group (Pearson coefficient -0.35 , $p = 0.355$).

The typical blood loss is 300–500 ml in patients undergoing THA for osteoarthritis without clotting abnormalities.^{16,17} In a recent study, reflecting current anaesthetic and surgical practice, blood loss after THA in 68 patients was shown to be 371 ± 347 ml and post-operative blood loss 66 ± 70 ml.¹⁸ For simplicity, normal intra-operative blood loss during THA was taken to be 400 ml. Table 6 shows that our outcomes using this as a normal reference range were either excellent ($n = 5$) or good ($n = 6$). Applying the same criteria to the Löfqvist et al. data shows that our results compared favourably.¹³

4. Discussion

Wiedel et al. state “it is not unusual to see a 6–8 g/dl decrease in haemoglobin, which may require a transfusion” in any major joint replacing surgery in a patient with haemophilia.⁶ Kasper et al. in one of the largest published series of surgeries on 163 patients with haemophilia A stated that “the frequency of postoperative bleeding correlated much better with the site and type of surgery than with the factor levels at the time of the incident”. They quoted a surgical-site haemorrhage rate of 40% for knee surgeries compared with 15% for “all other types of joint”, and an overall post-operative haemorrhage rate of 23%.⁹ This paper was published in 1985, and reflected surgical cases operated on between 1967 and 1983 – over 30 years ago. Further advances in the haematological management of haemophilia with factor replacement have led a reported reduction in the risk of a significant intra-operative event in all surgery types.⁸ There is some disparity in the literature as to blood loss and bleeding risks in patients with haemophilia undergoing THR. The aim of this current study was to determine the risk of bleeding in the peri-operative period, including the risk of haematoma formation and the peri-operative blood transfusion requirements in a cohort of patients with haemophilia undergoing THA and compare our results to the available current published data.

Only one paper in the published literature evaluated blood loss as a primary outcome measure. Löfqvist et al. reviewed 13 patients and showed that the mean blood loss was 900 ml with a range 400–2900 ml. One patient however, underwent simultaneous bilateral THA and had a blood loss of 2900 ml which was a notable outlier. Also, one patient had inhibitors and that patient's total blood loss was 1800 ml. Given that the total number of patients/cases in the group was small (11/13 in total) these two results skewed the mean results. Excluding these two patients, the mean blood loss was reduced to 630 ml. Overall our mean blood loss was less (502 ml) and interestingly both results were an average of similar numbers of comparable patients (12 and 10). The maximum blood loss was slightly higher at 1250 ml compared to 1000 ml but even this patient required no transfusion.¹²

The definition of normal blood loss as it pertains to THA has previously been difficult to define. Miles et al. reviewed 24 patients (34 THA) with haemophilia in two centres in Spain and UK over a 22-year period.¹⁹ They reported no serious problems with bleeding and found the post-operative blood loss comparable to that seen in patients having THA for osteoarthritis with no patients needed transfusion. However, no reference was given for the “normal” or expected amount, and there were no data presented on actual blood loss in the haemophilia group. Sikkema et al. found no increased incidence of blood loss or haematoma complications in a cohort of six patients and Haberman et al. found that blood loss did not exceed the normal distribution even when compared to individuals with bleeding disorders. However, this was without any reference to what “normal” blood loss was, or what the total amount was for the haemophilia patients.^{20,21}

In a more comprehensive study, Yoo et al. objectively measured blood loss in group of 23 patients undergoing THA for end-stage haemophilic arthropathy and found that mean blood transfusion requirements intraoperatively were 1.5 units (range 0–5 units) of packed red cells and 0.5 units (range 0–5 units) of fresh frozen plasma (FFP), and mean of 1.33 units (range 0–3 units) of packed red cells in the postoperative period with one patient requiring “massive transfusion” despite adequate pre-operative factor levels.²² Nelson et al. state that the range of blood loss in a group of 38 patients with haemophilia was 300–1000 ml, but they did not report a mean value, which makes this hard to interpret. Equally they state that mean transfusion requirements were 2–3 units RCC, but no information on the number of patients or the individual transfusion requirements was presented. They did note complications of haematoma formation in 3/29 patients (7.7%) which is higher than we found.¹³

In a large multi-centre study, Toy et al. estimated the mean blood loss for 324 primary THA to be in the order of 3.2 ± 1.3 units RCC, and the mean volume transfused if required was 2 units RCC.²³ Various factors such as type of anaesthesia, operative approach, procedure duration and implant type can have an influence the total amount. Even when all influencing factors are equal, blood loss is still variable.²⁴ Up to 50% of patients have been reported to require a blood transfusion post-operatively, however, the rates of transfusion have been significantly decreased (to approx. 21%) since the introduction of more standardised guidelines.^{25–27} There was no incidence of haematoma formation in our study, and only one patient required a transfusion of 2 units RCC, which is comparable to both the mean population according to Toy and the peri-operative transfusion volume of 2.8 units RCC according to Yoo et al.^{19,23} The comparable transfusion requirements may be because the patients with haemophilia tend to be younger overall and may tolerate a higher blood loss without the need for transfusion. The mean age in our study was 56 years, and 36 years in the patient group from Yoo et al.²²

Haemoglobin drops have been suggested to be a better estimate of overall blood loss than intra-operative assessment, but in a large study of 198 orthopaedic patients undergoing major surgery, Howe et al. demonstrated that clinical estimation of blood loss correlated well with actual change in peri-operative haemoglobin.^{28,29} Perazzo et al. showed that the mean Hb drop in 312 patients following THA was 2.6 g/dl, whereas Callaghan et al. have shown it to be higher at 4.07 g/dl.^{30,31} In this study haemoglobin values were recorded, but there was no data for comparison from other published literature evaluating blood loss in haemophilia patients, nor are there any guidelines in WHR documentation on Haemoglobin assessments. Our mean Hb drop was shown to be 3.25 g/dl (1.9–5.1 g/dl) and this is actually lower than the reported values in cohorts without bleeding disorders. The benefit of recording this data is that it is objective, and can be assessed in all patients regardless of whether or not a drain is sited. We found no correlation between intra-operative EBL and a change in Hb at 48 h.

We acknowledge that the small numbers in the study, as well as its retrospective nature limits full analysis. In some cases the data collection was incomplete, however the numbers in this study of a rare disease were comparable to other published series.

5. Conclusion

In conclusion, the results of our study compare similarly with the reported blood loss in the literature and by assessment with International Guidelines. Though average blood loss in patients with haemophilia was higher than the quoted normal reference of 400 ml as established in the literature, this was not shown to be statistically significant, and there were neither increased transfusion requirements nor evidence of clinically significant haematoma.

Conflicts of interest

The authors have none to declare.

References

- Mann HA, Choudhury MZ, Allen DJ, Lee CA, Goddard NJ. Current approaches in haemophilic arthropathy of the hip. *Haemophilia*. 2009;15(May (3)):659–664.
- Wang K, Street A, Dowrick A, Liew S. Clinical outcomes and patient satisfaction following total joint replacement in haemophilia – 23-year experience in knees, hips and elbows. *Haemophilia*. 2012;18(January (1)):86–93.
- Hilgartner MW. Current treatment of hemophilic arthropathy. *Curr Opin Pediatr*. 2002;14:46–49.
- Rodríguez-Merchán EC. Management of the orthopaedic complications of haemophilia. *J Bone Jt Surg Br*. 1998;80:B191–B196.
- Heeg M, Meyer K, Smid WM, Van Hor JR, Van der Meer J. Total knee and hip arthroplasty in haemophilic patients. *Haemophilia*. 1998;(September (5)):747–751.
- Wiedel J. *Joint Replacement Surgery in Hemophilia. Treatment in Haemophilia*. No 50. 2010, June. www.wfh.org/publication/files/pdf-1210.pdf
- Silva M, Luck Jr JV. Long-term results of primary total knee replacement in patients with hemophilia. *J Bone Jt Surg Am*. 2005;87A:85–91.
- Pasta G, Perfetto OS, Solimeno LP. Ten years experience of TKRs in haemophilic patients: the surgical unsolved problems. *Haemophilia*. 2004;10:80.
- Kasper CK, Boylen AL, Ewing NP, Luck Jr JV, Dietrich SL. Hematologic management of hemophilia A for surgery. *JAMA*. 1985;253(1279).
- Bellingham A, Fletcher D, Kirwan EO, Pranker TA, Cleghorn T. Hip arthroplasty in a haemophilic and subsequent prophylactic therapy with cryoprecipitate. *Br Med J*. 1967;4(December (5578)):531–532.
- Kelley SS, Lachiewicz PF, Gilbert MS, Bolander ME, Jankiewicz JJ. Hip arthroplasty in haemophilic arthropathy. *J Bone Jt Surg Am*. 1995;77:828–834.
- Löfquist T, Sanzén L, Petersson C, Nilsson IM. Total hip replacement in patients with hemophilia. *Acta Orthop Scand*. 1996;4:747–751.
- Nelson IW, Sivamurugan S, Latham PD, Matthews J, Bulstrode CJ. Total hip arthroplasty for haemophilic arthroplasty. *Clin Orthop*. 1992;276:210–213.
- White GC, Rosendaal F, Aledort LM, Lusher JM, Rothschild C, Ingersley J. Definitions in hemophilia. Recommendations of the scientific subcommittee on factor VIII and factor IX of the scientific and standardization committee of the International Society on Thrombosis and Haemostasis. *Thromb Haemost*. 2001;85(March (3)):560.
- Haemostasis Guidelines. National Centre for Hereditary Coagulation Disorders, St James's Hospital, Dublin.
- Bromhead H. Anaesthesia for hip arthroplasty. *ATOTW*. 2007;62:.
- Austin MS, Hozack WJ, Sharkey PF, Rothman RH. Stability and leg length equality in total hip arthroplasty. *J Arthroplasty*. 2003;18(April (3 suppl 1)):88–90.
- Menezes S, Manso T, Seifert I, Rodrigues R, Gil G. Blood loss after THR in 68 patients undergoing (371 ± 347 ml). *Eur J Anaesthesiol*. 2011;28(June):92.
- Miles J, Rodríguez-Merchán EC, Goddard NJ. The impact of haemophilia on the success of total hip arthroplasty. *Haemophilia*. 2008;14(January (1)):81–84.
- Sikkema T, Boerboom AL, Meijer K. A comparison between the complications and long-term outcome of hip and knee replacement therapy in patients with and without haemophilia: a controlled retrospective cohort study. *Haemophilia*. 2011;17(March (2)):300–303.
- Habermann B, Eberhardt C, Hovy L, Zichner L, Scharrer I, Kurth AA. Total hip replacement in patients with severe bleeding disorders. A 30 years single center experience. *Int Orthop*. 2007;31(February (1)):17–21.
- Yoo MC, Cho YJ, Kim KI, Ramteke A, Chun YS. The outcome of cementless total hip arthroplasty in haemophilic hip arthropathy. *Haemophilia*. 2009;15(May (3)):766–773.
- Toy PT, Kaplan EB, McVay PA, Lee SJ, Strauss RG, Stehling LC. Blood loss and replacement in total hip arthroplasty: a multicenter study. The Preoperative Autologous Blood Donation Study Group. *Transfusion*. 1992;32(1):63–67.
- Walker RW, Rosson JR, Bland JM. Blood loss during primary total hip arthroplasty: use of preoperative measurements to predict the need for transfusion. *Ann R Coll Surg Engl*. 1997;79(November (6)):438–440.
- Bierbaum B, Callaghan JJ, Galante JO, Rubash HE, Tooms RE, Welch RB. An analysis of blood management in patients having a total hip or knee arthroplasty. *J Bone Jt Surg Am*. 1999;81-A(1):2–10.
- Aderinto J, Brenkel JJ. Pre-operative predictors of the requirement for blood transfusion following total hip replacement. *J Bone Jt Surg Br*. 2004;86(September (7)):970–973.
- Primary Total Hip Replacement – A Guide to Good Practice*. Blue Book 2006. British Orthopaedic Association; 1999.
- García J, Bermejo S, Sánchez S, Vallés J, Puig L, Escolano F. Correct assessment of blood loss and haemoglobin levels for good postoperative management after knee arthroplasty. *Eur J Anaesthesiol*. 2005;22(May):79–80.
- Howe C, Paschall C, Panwalkar A, Beal J, Potti A. A model for clinical estimation of perioperative hemorrhage. *Clin Appl Thromb Hemost*. 2003;9(April (2)):131–135.
- Perazzo P, Viganò M, De Girolamo L, et al. Blood management and transfusion strategies in 600 patients undergoing total joint arthroplasty: an analysis of pre-operative autologous blood donation. *Blood Transfus*. 2013;11(July (3)):370–376.
- Callaghan JJ, Spitzer A. Blood management and patient specific transfusion options in total joint replacement surgery. *Iowa Orthop J*. 2000;26–35.
- Rodríguez-Merchán EC. Haemophilic synovitis: basic concepts. *Haemophilia*. 2007;13(suppl 3):1–3.