

Frequency of Transfusions and Risk Factor for Bleeding Risk to Guide a Blood-Sparing Program during Hip Arthroplasty in Gabon

Ghislain Edjo Nkilly^{1*}, Raphael Okoue Ondo¹, Arthur Matsanga², Pascal Christian Nze Obiang³, Stéphane Oliveira⁴, Léandre Nguiabanda⁵, Jean-Marcel Mandji-Lawson⁴, Romain Tchoua¹

¹Department of Anaesthesia and Intensive Care, Omar Bongo Ondimba Army Training Hospital (HIAOBO), Libreville, Gabon

²Department of Anaesthesia and Intensive Care, Owendo University Hospital (CHUO), Libreville, Gabon

³Department of Anaesthesia and Intensive Care, Jeanne Ebori Fondation, Libreville, Gabon

⁴Department of Anaesthesia and Intensive Care, Akanda Army Training Hospital, Libreville, Gabon

⁵Orthopedic surgery service, Omar Bongo Ondimba Army Training Hospital (HIAOBO), Libreville, Gabon

Email: *edjonkillyghislain@yahoo.fr

How to cite this paper: Nkilly, G.E., Ondo, R.O., Matsanga, A., Obiang, P.C.N., Oliveira, S., Nguiabanda, L., Mandji-Lawson, J.-M. and Tchoua, R. (2023) Frequency of Transfusions and Risk Factor for Bleeding Risk to Guide a Blood-Sparing Program during Hip Arthroplasty in Gabon. *Open Journal of Anesthesiology*, 13, 47-57.

<https://doi.org/10.4236/ojanes.2023.133005>

Received: October 30, 2022

Accepted: March 13, 2023

Published: March 16, 2023

Copyright © 2023 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

Background: Hip arthroplasty is a surgery with a high risk of bleeding. The main objective of this study was to research risk factors for bleeding and transfusion in patients undergoing hip arthroplasty in order to guide a blood-saving program. **Method:** Retrospective, monocentric, descriptive and analytical study carried out from June 2011 to June 2021 at the Omar Bongo Ondimba army training hospital. The variables studied were demographic characteristics, biological variables, transfusion data, anesthetic and intraoperative data. The primary outcome was intraoperative or postoperative transfusion. A univariate and multivariate analysis was conducted to identify the factors associated with the occurrence of a transfusion. **Results:** Of the 276 patients included, 179 benefited from Total Hip Prosthesis (THP) and 97 from Intermediate Hip Prosthesis (IHP). Spinal anesthesia was performed in 67.4% of patients. The ASA 2 score predominated (65.9%). The transfusion incidence was 56.9% (157/276). Tranexamic acid was used in 16.3% (45/276) of patients. The average bleeding was 528 ± 405 ml. Preoperative anemia (OR = 0.78, 95% CI [0.66 - 0.91]) and total hip prosthesis (OR = 2.02 95% CI [1.11 - 3.67]) were predictors of bleeding and transfusion to be significant. The average serum hemoglobin predictive of a transfusion was 11.6 ± 1.8 . ASA score and operative time were not found as risk factors for bleeding and transfusion. **Conclusion:** The incidence of transfusion is high. Preoperative anemia remains a major but modifiable risk factor unlike the choice of implant. The implementation of a patient blood management protocol could reduce this transfusion incidence.

Keywords

Arthroplasty, Hip, Gabon, Transfusion

1. Introduction

Arthroplasty is a common intervention in orthopedic surgery. It is an intervention with a high hemorrhagic risk, it is often accompanied by blood transfusion. Despite improvements in transfusion safety in recent years, allogeneic blood transfusion still leads to complications, including allergic reactions, infections, circulatory overload and lung damage [1]. In addition, studies have shown that blood transfusions can be responsible for prolonged hospitalization, mortality and high postoperative morbidity during hip and knee arthroplasty [2] [3]. Hip arthroplasty has been performed in Gabon since 2011 at the Omar Bongo Ondimba Army Training Hospital in Libreville (HIAOBO). This surgical activity was accompanied by a blood transfusion which seemed important to us and did not benefit from a specific protocol concerning transfusion, unlike the prevention of the risk of infection which was the subject of a protocol with antibiotic prophylaxis, research urinary, dental, sinus and pulmonary infection. No study had been carried out on transfusion practice during hip arthroplasty in Gabon. The aim of the study was to look for risk factors for transfusion during hip arthroplasty at the Omar Bongo Ondimba Army Training Hospital in Libreville (HIAOBO) to guide a blood saving program

2. Material and Method

Retrospective, descriptive, analytical study. Performed in the Anesthesia Resuscitation department of HIAOBO over 11 years, from January 2011 to June 2021.

Inclusion criteria: Patients who underwent prosthetic hip prosthesis surgery such as total hip prosthesis (THA) or intermediate hip prosthesis (IPH) were included.

Non-inclusion criteria: patients who underwent DHS (dynamic hip screw) or Gamma nail were not included.

Study variables: The variables studied were sociodemographic (age, sex, weight, height, BMI, history), comorbidities (arterial hypertension, diabetes, renal failure, HIV, sickle cell disease), ASA score. Biologicals (NFS, urea, creatinine, blood ionogram, coagulation assessment, GsRh, RAI, bilirubin, troponin). Operating variables (anesthesia, type of prostheses, tranexamic acid, operating time, blood loss), per and post complications operations, per and post-operative blood transfusion.

The variables studied were obtained from medical records (sociodemographic variables, comorbidities), surgical records (postoperative clinical and biological data) and anesthetic records (technical and operative data). All these variables were listed on a survey sheet separated into 3 periods (pre, per and post opera-

tive). After discharge from hospital, patients were systematically seen by the surgeon on D14, D21 and D30 as part of the follow-up to obtain late data. All the operated patients carried out an infectious assessment in search of a urinary, dental, sinus infection and antibiotic prophylaxis during the surgery. A cardiological evaluation by electrocardiogram and echocardiography was performed in all patients.

Statistical analysis: data were entered on computer and analyzed using Epi Info 7.2 software, IBM SPSS version 21 and Excel 2016. For data comparison, we used the Chi2 test, the Pearson test and the significance level $< 5\%$. The quantitative descriptive variables were expressed on average with the standard deviation. Qualitative variables were described as percentages. Nonparametric Kruskal Wallis tests for independent samples were used to compare quantitative variables by linear regressions. This made it possible to link together different quantitative variables with determination of the Pearson correlation coefficient. The difference was significant for p values less than 0.05.

3. Results

- Demography

The sample consisted of 276 patients with an average age of 64.3 ± 15.7 years with extremes of 17 and 95 years. There were 163 (59.3%) female patients and 112 (40.7%) male patients, a sex ratio of 0.69. The most represented comorbidities were arterial hypertension (42.7%) and diabetes (10.9%). The mean hemoglobin level was 11.9 ± 1.9 g/dl with a minimum of 5.7 and a maximum of 18.6. The population had an ASA score around 2. Patient characteristics are given in **Table 1(a)**.

The population was heterogeneous with two types of patients. Patients who benefited from total hip arthroplasty (THA) (64.9%) and another from intermediate hip arthroplasty (IHA) (35.1%) patients. **Table 1(b)** compares the two populations.

- Perioperative data

Spinal anesthesia was mainly performed. The operating time was relatively long. The mean hemoglobin level was 11.9 ± 1.9 g/dl with a minimum of 5.7 and a maximum of 18.6. **Table 2** summarizes the intraoperative data.

- Transfusion aspects

The average number of RBCs transfused was 1 with a maximum of 3 per patient and an average blood loss of 528.8 ± 405.8 ml and a maximum of 1900 ml. Transfusions were preferentially performed postoperatively with 96 (34.8%) patients for a total of 157 (56.9%) patients transfused. Tranexamic acid was used in 45 (16.3%) patients. No significant association between transfusion and tranexamic acid (**Table 3**).

- Univariate analysis: Comparison of transfused and non-transfused patients shows a significant difference in age, values hemoglobin, hematocrit and ASA score (**Table 4**).

Table 1. (a) Demographics; (b) Demographies.

(a)			
	demographics		
Age (years)			
- Mean			64.3 ± 15.7
- 17 - 24			7 (2.54%)
- 25 - 54			60 (21.7%)
- 55 - 74			128 (46.4%)
- Greater than 74			80 (29%)
Sex			
- Male			113 (41%)
- Female			163 (59%)
Comorbidities			
- High blood pressure			117 (42.4%)
- Diabetes			30 (10.7%)
- Obesity			20 (7.25%)
- Renal failure			6 (2.2%)
- sickle cell disease			5 (1.81%)
- HIV			3 (1.09%)
ASA score			
- Mean			1.8
- ASA 1			77 (27.9%)
- ASA 2			182 (65.9%)
- ASA3			17 (6.016%)
preoperative biology (Mean)			
- Hémoglobin (g/dl)			11.9 ± 1.9
- Hématocrit (%)			36.3 ± 5.7
- Platelets (/mm ³)			234.6 ± 96.2
- Urea (mmol/l)			5.3 ± 3.8
- Créatinine (μmol/l)			88.7 ± 73.8
- Blood sugar (mmol/l)			5.4 ± 1.3
(b)			
	IHA (n = 97)	THA (n = 179)	p
Age (years)	74.2 ± 10.6	59.0 ± 15.4	<0.001
ASA score	1.9 ± 0.5	1.7 ± 0.5	0.002
Hémoglobin (g/dl)	11.5 ± 2.0	12.2 ± 1.8	0.002
Hématocrit (%)	35.3 ± 5.8	36.9 ± 5.5	0.028
Créatinine (μmol/l)	96.5 ± 115.2	84.2 ± 30.5	0.219
Left ventricular ejection fraction (%)	69.1 ± 8.4	68.4 ± 8.5	0.569
Blood loss (ml)	450.0 ± 453.4	570.6 ± 378.6	0.313
Red blood cell count	2.1 ± 2.0	2.3 ± 1.9	0.390

Table 2. Intraoperative data.

	Intraoperative data
Anesthésia	
- Général anesthesia (GA)	87 (31.5%)
- Spinal anesthesia	186 (67.4%)
- GA and fémoral block	3 (1.1%)
Operating time (hour)	
- Mean	3.4 ± 0.9
Prosthesis	
- Total Hip Prosthesis (THP)	179 (64.9%)
- Intermediate Hip Prosthesis (IHP)	97 (35.1%)
Mean Intraoperative blood loss (ml)	528.8 ± 405

Table 3. Transfusion data.

Transfused patients	number	%
- Total	157/276	56.9%
- intraoperative	61/157	38.85
- Postoperative	96/157	61.15
Tranexamic acid	Number	%
- Tranexamic acid +	45/276	16.3
- Tranexamic acid -	231/276	83.7
Blood loss and tranexamic acid	ml	
- Ac tranexamique +	483 ± 479	p = 0.662
- Ac tranexamique -	543 ± 387	
Transfusion complications (numbers)	0	0

Table 4. Analysis of transfused and non-transfused populations.

	Transfused	Not transfused	p
Duration of stay (days)	17.4 ± 8.9	17.5 ± 8.7	0.926
Hémoglobine (g/dl)	11.6 ± 1.8	12.3 ± 1.9	0.004
Hématocrit (%)	35.6 ± 5.7	37.1 ± 5.6	0.042
Age (years)	63.1 ± 16.3	65.4 ± 15.0	0.208
ASA score	1.7 ± 0.5	1.9 ± 0.5	0.016
Créatinine (µmol/l)	92.3 ± 92.2	85.5 ± 51.8	0.485
Left ventricular ejection fraction (%)	68.4 ± 8.1	69.0 ± 8.7	0.647

- Multivariate analysis

After multivariate analysis, only hemoglobin level and Total Hip Arthroplasty remained significantly related to transfusion. All other factors (anesthetic technique, age, sex, operating time) were not related to transfusion (**Table 5**).

- Postoperative complications

Complications were mainly cardiovascular with 5 (1.8%) patients, respiratory and infectious complications had the same rate with 2 (0.7%) patients. The number of deaths was 4 (1.4%) patients, all related to coronary ischemia in patients admitted to intensive care (**Table 6**).

Table 5. Risk factors associated with transfusion by logistic regression.

	OR [IC 95%]	P
Hémoglobine (g/dl)	0.78 [0.66 - 0.91]	0.002
ASA score	0.60 [0.36 - 1.01]	0.054
Total Hip Prothesis (THP)	2.02 [1.11 - 3.67]	0.021

Table 6. Post operative complications.

	J7	J14	J21	J30
Death	2 (0.7%)	2 (0.7%)	0 (0)	0 (0)
Complications	9 (3.3%)	2 (0.7%)	1 (0.4%)	0 (0)
* Functional	2 (0.7%)	0 (0)	0 (0)	0 (0)
* Respiratory	1 (0.4%)	1 (0.4%)	1 (0.4%)	0 (0)
* Cardiovascular	4 (1.4%)	1 (0.4%)	0 (0)	0 (0)
* Infections	2 (0.7%)	0 (0)	0 (0)	0 (0)

4. Discussion

The aim of this study was to investigate the factors affecting perioperative hemoglobin loss and the frequency of transfusions in patients undergoing hip arthroplasty.

- **Epidémiology**

Study carried out on a heterogeneous population composed of patients having benefited from intermediate hip prosthesis (PIH) and patients benefiting from total hip prosthesis (THP). PIH is performed for fracture of the femoral neck, a pathology most often affecting elderly female subjects, while patients most often benefiting from THA for hip osteoarthritis are younger. Tables 1a and 1b summarize the characteristics of the two populations.

- **Transfusion**

The incidence of transfusion is high in our study population (56.9%), with relatively modest blood loss. Total hip arthroplasty (THA) is one of the most performed orthopedic procedures in the world. Studies show that up to 46% of patients require red blood cell transfusions during or after hip or knee replacement surgery [4] [5] [6]. As a risk factor for transfusion, it appeared the preoperative hemoglobin level and the installation of THA. Preoperative anemia is common in orthopedic arthroplasty surgery and is prevalent in approximately 25% of patients [2] [3] [7] [8]. Low preoperative Hb has been identified as an independent risk factor for postoperative transfusions after hip or knee arthroplasty [9] [10] [11] Ryan and al. reported a Hb of 12.5 g/dL as an optimal cutoff for predicting postoperative transfusion with a specificity 76.4% and a sensitivity of 84.8% in knee arthroplasty [12]. This anemia may be associated with high morbidity and mortality and a high incidence of red blood cell transfusions [7]. Our study finds an overall average of 11.9 g/dl including 11.5 g/dl for patients

receiving PIH and 12.2 g/dl for patients receiving PTH, these preoperative hemoglobin levels partly explain the high rate of transfusion.

The total hip prosthesis was found to be a risk factor for transfusion, in fact, the intermediate hip prosthesis is known to be less hemorrhagic than the total prosthesis, which would be explained by the fact that the surgical procedure during the total prosthesis is more heavy with more bleeding according to some studies [13] [14]. Liodakis and al found an increase in the number of transfusions in the total hip arthroplasty versus intermediate hip arthroplasty [15]

Tranexamic acid has been used very little in our practice (45 patients) mainly for reasons of availability, its low impact on the reduction of bleeding is certainly linked to selection bias and the small sample of patients who have benefited from this treatment. Since a long time Tranexamic acid has been proved to be effective in preventing blood transfusions as well as reducing perioperative blood loss. Meta-analysis of Sadigursky (7 randomized clinical trials, 948 patients) and Rajiv Gandhi (33 clinical trials, 403 patients) reported a reduced blood loss and lower transfusion rates for patients receiving tranexamic acid, without an increased risk for deep vein thrombosis, pulmonary embolism or other complications [16] [17]. These findings are consistent with our results. However, some outcomes indicate that the avoidance of suction drains might be as important as the use of tranexamic acid for the reduction of perioperative blood loss. There are many areas for improvement in order to reduce transfusion: this is how perioperative blood optimization programs have been developed in the last years to reduce transfusion frequency and to increase patient safety. These programs include the pre-operative optimization of the hemoglobin level and the optimal hemostasis obtained during surgery.

Various studies have shown a significant lower blood loss by using the minimal invasive surgery compared to the standard approach due to smaller skin and muscle incisions [18] [19]. This technique is not yet available to us, hip arthroplasty is a recent surgery in our structure, since 2013

- Optimal hemostasis during surgery was maintained by avoiding hypothermia and optimization of pH level. A meta-analysis reported that even mild hypothermia significantly increases blood loss and the risk for transfusion by 22% [20]. In addition, RBC transfusions were administered restrictively only in patients with $Hb \leq 6$ g/dL or in symptomatic patients with $Hb \leq 8$ g/dL

- The coadministration of erythropoietin has shown to further reduce blood transfusions in patients undergoing hip surgery [21]. Several studies have reported that blood transfusions are associated with an increased perioperative mortality, more complications, especially surgical site infections and prolonged hospitalization [4] [7] [22] [23]. In our study there were 12 complications between Day 7 and Day 21 mainly coronary ischemia, 2 infections and 04 deaths (Table 6).

- Some studies show that anesthetic technique can influence bleeding and transfusion during hip arthroplasty, particularly total arthroplasty. According to

Owen and al, patients who received spinal anesthesia had lower mean pain scores throughout length of their hospitalizations, and required fewer blood transfusions (OR, 0.7), length of stay was not significantly different between the groups, and there was no difference in readmissions at 30 or 90 days or venous thromboembolic events at 90 days [24]. The Memtsoudis meta-analysis (94 studies) also shows a reduction in bleeding and transfusion in patients undergoing spinal anesthesia [25].

5. Study Limitations

1) The present study has several limitations, mainly due to its retrospective design. Secondly, patients have been operated by different surgeons, which might have influenced bleeding. Thirdly, the criteria for insertion of suction drains were systematic, thus, surgeons' expertise and patient risk factors may have influenced the decision on the use of suction drains.

2) Not taking into account blood loss through the drains. The insertion of drains after knee or hip arthroplasty is still a matter of controversy [26] [27] [28]. tranexamiqThe insertion of a suction drain has no scientifically proven benefits and drains are not used routinely anymore. Using enhanced recovery protocols in the arthroplasty leads to a changing role for drains, particularly with the use of tranexamic acid. Most literature is from the pre-tranexamic era and there are only few studies on the use of drains in combination with tranexamic acid. In our study, this aspect was not taken into account although in our practice, the installation of drains is very frequent and depends on the surgeons.

3) The absence of iron balance to look for iron deficiency anemia, probably because iron deficiency anemia has been known to be endemic in Africa for a very long time [29]. Iron deficiency anemia is the most common type of anemia in patients undergoing hip and knee replacement surgery and can be accompanied by increased length of hospital stay, high readmission rate at 90 days and postoperative complications [30] [31].

6. Conclusions

Preoperative anemia and Total Hip Arthroplasty are the main risk factors for transfusion during hip arthroplasty. The establishment of a blood-saving program centered on modifiable factors (anemia, iron deficiency) associated with better use of tranexamic acid could reduce the incidence of transfusion, improve postoperative rehabilitation, save resources, reduce costs and improve patient safety.

Studies have shown the effectiveness of this kind of program. Polanco-García et al showed that a blood-sparing program reduced the frequency of transfusions from 41% to 16% by emphasizing the correction of preoperative anemia by the erythropoietin association and iron intake and intraoperative tranexamic acid [32], Kopanidis and al. achieved a lower blood transfusion rate and higher postoperative hemoglobin values after implementing a patient blood management

program [33], Pinilla-Gracia and al. also showed lower transfusion rates, shorter length of stay and a corrected preoperative anemia in 79% of cases [34]. In a financial aspect, Fenelon and al reported on a 46% reduction of cross-matched blood and an annual cost saving of €54,375 after introduction of an enhanced recovery program [35].

In this multidisciplinary blood saving program, the anesthesia team plays a key role in coordinating and planning the various procedures

Authors' Contributions

G. Edjo Nkilly: principal investigator, drafting the manuscript.

R. Okoue Ondo: inclusion and follow-up of patients.

A. Matsanga: inclusion and follow-up of patients.

PC. Nze Obiang: inclusion and follow-up of patients.

S. Oliveira: inclusion and follow-up of patients.

L. Nguiabanda: surgeon, inclusion and follow-up of patients.

JM Mandji-Lawson: reading final manuscript.

R. Tchoua: reading and final approval of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Taylor, R.W., *et al.* (2002) Impact of Allogenic Packed Red Blood Cell Transfusion on Nosocomial Infection Rates in the Critically Ill Patient. *Critical Care Medicine*, **30**, 2249-2254. <https://doi.org/10.1097/00003246-200210000-00012>
- [2] Spahn, D.R. (2010) Anemia and Patient Blood Management in Hip and Knee Surgery: A Systematic Review of the Literature. *Anesthesiology*, **113**, 482-495. <https://doi.org/10.1097/ALN.0b013e3181e08e97>
- [3] Jans, Ø., Jørgensen, C., Kehlet, H. and Johansson, P.I. (2014) Role of Preoperative Anemia for Risk of Transfusion and Postoperative Morbidity in Fast-Track Hip and Knee Arthroplasty. *Transfusion*, **54**, 717-726. <https://doi.org/10.1111/trf.12332>
- [4] Song, K., Pan, P., Yao, Y., Jiang, T. and Jiang, Q. (2019) The Incidence and Risk Factors for Allogenic Blood Transfusion in Total Knee and Hip Arthroplasty. *Journal of Orthopaedic Surgery and Research*, **14**, 273. <https://doi.org/10.1186/s13018-019-1329-0>
- [5] Menendez, M.E., *et al.* (2016) Variation in Use of Blood Transfusion in Primary Total Hip and Knee Arthroplasties. *The Journal of Arthroplasty*, **31**, 2757-2763. <https://doi.org/10.1016/j.arth.2016.05.022>
- [6] Carling, M.S., Jeppsson, A., Eriksson, B.I. and Brisby, H. (2015) Transfusions and Blood Loss in Total Hip and Knee Arthroplasty: A Prospective Observational Study. *Journal of Orthopaedic Surgery and Research*, **10**, 48. <https://doi.org/10.1186/s13018-015-0188-6>
- [7] Fowler, A.J., *et al.* (2015) Meta-Analysis of the Association between Preoperative Anaemia and Mortality after Surgery. *British Journal of Surgery*, **102**, 1314-1324. <https://doi.org/10.1002/bjs.9861>

- [8] Muñoz, M., *et al.* (2017) Pre-Operative Haemoglobin Levels and Iron Status in a Large Multicentre Cohort of Patients Undergoing Major Elective Surgery. *Anaesthesia*, **72**, 826-834. <https://doi.org/10.1111/anae.13840>
- [9] Noticewala, M.S., Nyce, J.D., Wang, W., Geller, J.A. and Macaulay, W. (2012) Predicting Need for Allogeneic Transfusion after Total Knee Arthroplasty. *The Journal of Arthroplasty*, **27**, 961-967. <https://doi.org/10.1016/j.arth.2011.10.008>
- [10] Guerin, S., Collins, C., Kapoor, H., McClean, I. and Collins, D. (2007) Blood Transfusion Requirement Prediction in Patients Undergoing Primary Total Hip and Knee Arthroplasty. *Transfusion Medicine*, **17**, 37-43. <https://doi.org/10.1111/j.1365-3148.2006.00698.x>
- [11] Ogbemudia, A.E., Yee, S.Y., MacPherson, G.J., Manson, L.M. and Breusch, S.J. (2013) Preoperative Predictors for Allogenic Blood Transfusion in Hip and Knee Arthroplasty for Rheumatoid Arthritis. *Archives of Orthopaedic and Trauma Surgery*, **133**, 1315-1320. <https://doi.org/10.1007/s00402-013-1784-8>
- [12] Ryan, S.P., *et al.* (2019) Preoperative Hemoglobin Predicts Postoperative Transfusion Despite Antifibrinolytics during Total Knee Arthroplasty. *Orthopedics*, **42**, 103-109. <https://doi.org/10.3928/01477447-20190225-05>
- [13] Keating, J.F., Grant, A., Masson, M., *et al.* (2006) Randomized Comparison of Reduction and Fixation, Bipolar Hemiarthroplasty, and Total Hip Arthroplasty. Treatment of Displaced Intracapsular Hip Fractures in Healthy Older Patients. *The Journal of Bone and Joint Surgery. American Volume*, **88**, 249-260. <https://doi.org/10.2106/JBJS.E.00215>
- [14] Voskuijl, T., Neuhaus, V., Kinaci, A., *et al.* (2014) In-Hospital Outcomes after Hemiarthroplasty versus Total Hip Arthroplasty for Isolated Femoral Neck Fractures. *Journal of Bone and Joint Surgery*, **2**, 151-156.
- [15] Liodakis, E., Antoniou, J., Zukor, D.J., *et al.* (2016) Major Complications and Transfusion Rates after Hemiarthroplasty and Total Hip Arthroplasty for Femoral Neck Fractures. *The Journal of Arthroplasty*, **31**, 2008-2012. <https://doi.org/10.1016/j.arth.2016.02.019>
- [16] Zhang, H., Chen, J., Chen, F. and Que, W. (2012) Effect of Tranexamic Acid on Blood Loss and Use of Blood Products in Total Knee Arthroplasty: A Meta-Analysis. *Knee Surgery, Sports Traumatology, Arthroscopy (KSSA)*, **20**, 1742-1752. <https://doi.org/10.1007/s00167-011-1754-z>
- [17] Gandhi, R., Evans, H.M.K., Mahomed, S.R. and Mahomed, N.N. (2013) Tranexamic Acid and the Reduction of Blood Loss in Total Knee and Hip Arthroplasty: A Meta-Analysis. *BMC Research Notes*, **6**, 184. <https://doi.org/10.1186/1756-0500-6-184>
- [18] Martin, R., Clayson, P.E., Troussel, S., Fraser, B.P. and Docquier, P.-L. (2011) Anterolateral Minimally Invasive Total Hip Arthroplasty: A Prospective Randomized Controlled Study with a Follow-Up of 1 Year. *The Journal of Arthroplasty*, **26**, 1362-1372. <https://doi.org/10.1016/j.arth.2010.11.016>
- [19] Speranza, A., Iorio, R., Ferretti, M., D'Arrigo, C. and Ferretti, A. (2007) A Lateral Minimal-Incision Technique in Total Hip Replacement: A Prospective, Randomized, Controlled Trial. *HIP International*, **17**, 4-8. <https://doi.org/10.5301/HIP.2008.492>
- [20] Rajagopalan, S., Mascha, E., Na, J. and Sessler, D.I. (2008) The Effects of Mild Perioperative Hypothermia on Blood Loss and Transfusion Requirement. *Anesthesiology*, **108**, 71-77. <https://doi.org/10.1097/01.anes.0000296719.73450.52>
- [21] Muñoz, M., Gómez-Ramírez, S. and Auerbach, M. (2016) Stimulating Erythropoiesis before Hip Fracture Repair for Reducing Blood Transfusion: Should We Change

- the Hemoglobin Cut of Level for Defining Anemia in Females? *Transfusion*, **56**, 2160-2163. <https://doi.org/10.1111/trf.13750>
- [22] Friedman, R., Homering, M., Holberg, G. and Berkowitz, S.D. (2014) Allogeneic Blood Transfusions and Postoperative Infections after Total Hip or Knee Arthroplasty. *The Journal of Bone and Joint Surgery. American Volume*, **96**, 272-278. <https://doi.org/10.2106/JBJS.L.01268>
- [23] Roque-Castellano, C., *et al.* (2016) Perioperative Blood Transfusion Is Associated with an Increased Mortality in Older Surgical Patients. *World Journal of Surgery*, **40**, 1795-1801. <https://doi.org/10.1007/s00268-016-3521-2>
- [24] Owen, A.R., *et al.* (2022) Spinal Compared with General Anesthesia in Contemporary Primary Total Hip Arthroplasties. *The Journal of Bone and Joint Surgery. American Volume*, **104**, 1542. <https://doi.org/10.2106/JBJS.22.00280>
- [25] Memtsoudis, S.G., Cozowicz, C., Bekeris, J., *et al.* (2019) Anaesthetic Care of Patients Undergoing Primary Hip and Knee Arthroplasty: Consensus Recommendations from the International Consensus on Anaesthesia-Related Outcomes after Surgery Group (ICAROS) Based on a Systematic Review and Meta-Analysis. *British Journal of Anaesthesia*, **123**, 269-287.
- [26] Maniar, R.N., *et al.* (2019) Role of Suction Drain after Knee Arthroplasty in the Tranexamic Acid Era: A Randomized Controlled Study. *Clinics in Orthopedic Surgery*, **11**, 73-81. <https://doi.org/10.4055/cios.2019.11.1.73>
- [27] Sharma, G.M., Palekar, G. and Tanna, D.D. (2016) Use of Closed Suction Drain after Primary Total Knee Arthroplasty—An Overrated Practice. *SICOT-J*, **2**, 39. <https://doi.org/10.1051/sicotj/2016034>
- [28] Chen, Z.-Y., Gao, Y., Chen, W., Li, X. and Zhang, Y.-Z. (2014) Is Wound Drainage Necessary in Hip Arthroplasty? A Meta-Analysis of Randomized Controlled Trials. *The European Journal of Orthopaedic Surgery and Traumatology*, **24**, 939-946. <https://doi.org/10.1007/s00590-013-1284-0>
- [29] DeMaeyera, E. and Adiels-Tegmanb, M. (1985) La prévalence de l'anémie dans le monde. Rapport Trimestriel. *Statistique Santé Monde*, 38.
- [30] Mathew, K.K., *et al.* (2020) Is Iron Deficiency Anemia a Risk Factor for Poorer Outcomes in Primary Total Knee Arthroplasty? *The Journal of Arthroplasty*, **35**, 1252-1256. <https://doi.org/10.1016/j.arth.2020.01.021>
- [31] Viola, J., Gomez, M.M., Restrepo, C., Maltenfort, M.G. and Parvizi, J. (2015) Preoperative Anemia Increases Postoperative Complications and Mortality Following Total Joint Arthroplasty. *The Journal of Arthroplasty*, **30**, 846-848. <https://doi.org/10.1016/j.arth.2014.12.026>
- [32] Polanco-Garcia, M., Capielo, A.M., Miret, X., *et al.* (2018) Effectiveness of a Patient Blood Management Protocol on Reduction of Allogeneic Red Blood Cell Transfusions in Orthopedic Surgery. *Medicina Clinica*, **152**, 90-97. <https://doi.org/10.1016/j.medcle.2018.12.004>
- [33] Kopanidis, P., *et al.* (2016) Perioperative Blood Management Programme Reduces the Use of Allogenic Blood Transfusion in Patients Undergoing Total Hip and Knee Arthroplasty. *Journal of Orthopaedic Surgery and Research*, **11**, 28. <https://doi.org/10.1186/s13018-016-0358-1>
- [34] Pinilla-Gracia, C., Mateo-Agudo, J., Herrera, A. and Muñoz, M. (2020) On the Relevance of Preoperative Haemoglobin Optimisation within a Patient Blood Management Programme for Elective Hip Arthroplasty Surgery. *Blood Transfusion*, **18**, 182-190.
- [35] Fenelon, C., *et al.* (2018) Saving Blood and Reducing Costs: Updating Blood Transfusion Practice in Lower Limb Arthroplasty. *Irish Medical Journal*, **111**, 730.