Intra-operative blood salvage in total hip and knee arthroplasty

Dan, Michael; Liu, David; Martos, Sara Martinez; Beller, Elaine

Published in:
Journal of Orthopaedic Surgery

DOI:
10.1177/1602400217

Published: 01/08/2016

Document Version:
Publisher's PDF, also known as Version of record

Licence:
CC BY-NC

Recommended citation (APA):
Dan, M., Liu, D., Martos, S. M., & Beller, E. (2016). Intra-operative blood salvage in total hip and knee arthroplasty. Journal of Orthopaedic Surgery, 24(2), 204-208. https://doi.org/10.1177/1602400217
Intra-operative blood salvage in total hip and knee arthroplasty

Michael Dan,1,2 David Liu,3 Sara Martinez Martos,3 Elaine Beller4

1 John Hunter Hospital, NSW, Australia
2 Department of Medicine, Bond University, Gold Coast, Queensland Australia
3 Gold Coast Centre for Bone and Joint Surgery, Gold Coast, Australia
4 Centre for Research in Evidence-Based Practice, Bond University, Gold Coast, Queensland, Australia

ABSTRACT

Purpose. To review records of 371 patients who underwent total hip or knee arthroplasty (THA or TKA) with intra-operative blood salvage to determine the allogeneic blood transfusion rate and the predictors for allogeneic blood transfusion.

Methods. Records of 155 male and 216 female consecutive patients aged 17 to 95 (mean, 70) years who underwent primary THA or TKA by a single surgeon with the use of intra-operative blood salvage were reviewed.

Results. The preoperative haemoglobin level was <120 g/dl in 15% of THA patients and 5% of TKA patients; the allogeneic transfusion rate was 24% in THA patients and 12% in TKA patients. Despite routine use of intraoperative blood salvage, only 59% of THA patients and 63% of TKA patients actually received salvaged blood, as a minimum of 200 ml blood loss was required to activate blood salvage. In multivariable analysis, predictors for allogeneic blood transfusion were female gender (adjusted odds ratio [OR]=2.8, p=0.02), age >75 years (adjusted OR=5.9, p<0.001), and preoperative haemoglobin level <120 g/l (adjusted OR=30.1, p<0.001), despite the use of intra-operative blood salvage. Patients who received allogeneic blood transfusion had a longer hospital stay and greater complication rate.

Conclusion. Intra-operative blood salvage is not effective in preventing allogeneic blood transfusion in patients with a preoperative haemoglobin level <120 g/l. It should be combined with preoperative optimisation of the haemoglobin level or use of tranexamic acid.

Key words: arthroplasty, replacement, hip; arthroplasty, replacement, knee; blood transfusion; operative blood salvage

INTRODUCTION

Substantial peri-operative blood loss in total hip and knee arthroplasty (THA and TKA) may lead to postoperative anaemia and necessitate allogeneic blood transfusion, with the rate being 57% and 39%, respectively. Total joint arthroplasty and fracture surgery account for most cases of allogeneic
blood transfusion, compared with other surgical specialties. Nonetheless, allogeneic blood transfusion is associated with risks of disease transmission, haemolytic reactions, immunomodulation, haemodynamic overload, acute lung injury, and coagulopathy. Patients who receive allogeneic blood have an increased risk of postoperative infection, longer hospital stay, and mortality. Various blood conservation strategies have been recommended. Nonetheless, preoperative autologous blood donation is not cost-effective and there is a high rate of unused blood. The effectiveness of acute normovolaemic haemodilution is debatable. Postoperative re-transfusion may result in transfusion reactions, as unwashed blood contains fibrin degradation products and other contaminants.

Intra-operative blood salvage re-transfuses washed blood that is removed of biochemical, cellular, and non-cellular debris including activated clotting factors, fatty lipids, and bone, and results in minimal disruption to surgical workflow. Intra-operative blood salvage has been reported to decrease the allogeneic blood transfusion rate varying from 57% to 6%, 8% to 15% in THA, and from 39% to 7%, 11%, and 16% in TKA. This study reviewed records of 371 patients who underwent THA or TKA with the use of intra-operative blood salvage to determine the allogeneic blood transfusion rate and the predictors for allogeneic blood transfusion.

MATERIALS AND METHODS

This study was approved by our hospitals’ regional ethics committee. The proportion of patients who would require blood transfusion was assumed to be 20%, and thus 246 patients were required to obtain a 95% confidence interval (CI) with a maximum error of 0.05. Records of 155 male and 216 female consecutive patients aged 17 to 95 (mean, 70) years who underwent primary THA (n=135) or TKA (n=236) by a single surgeon from January 2010 to December 2011 (prior to the introduction of tranexamic acid) with the use of intra-operative blood salvage were reviewed. THA was performed through an anterolateral approach with the patient in a lateral position. Uncemented acetabular and femoral components were used (Exceed acetabular cup Taperloc femoral stem, Biomet, Warsaw [IN], USA); no drain was used. TKA was performed through a standard medial parapatellar approach without tourniquet use. Computer navigation was used for alignment and preparation. Cemented femoral, tibial, and patellar components were used (Legion Primary, Smith and Nephew, Memphis [TE], USA). An intra-articular drain on low suction was removed on day 1. All patients received enoxaparin 40 mg daily for venous thromboembolic prophylaxis, commencing 4 hours postoperatively and continued for 14 days for TKA and 28 days for THA. Aspirin was continued throughout the perioperative period if it was already prescribed.

Using the Haemonetics Cell Saver 5+ machine (Brainintree [MA], USA), salvaged blood was washed and concentrated prior to re-transfusion in the recovery room. Haemoglobin level was checked on postoperative day 1. The transfusion trigger was patient-specific, based on the guidelines of the National Blood Authority of Australia. An absolute trigger was a haemoglobin level <80 g/l. Patients with symptomatic anaemia and significant comorbidities may be given transfusion at a haemoglobin level <100 g/l, based on the surgeon’s decision.

Binary variables were presented in proportion; normally distributed variables were presented as mean±standard deviation and compared using independent t-test; non-normally distributed variables were presented as median and inter-quartile range and compared using Mann-Whitney U test; discrete variables were presented as percentages and compared using Pearson Chi-squared test. Univariate and multivariate analyses were used to determine predictors for allogeneic blood transfusion, a p value of ≤0.10 and <0.05 was considered significant, respectively.

RESULTS

The preoperative haemoglobin level was <120 g/dl in 15% of THA patients and 5% of TKA patients; the allogeneic transfusion rate was 24% in THA patients and 12% in TKA patients (Table 1). Despite routine use of intra-operative blood salvage, only 59% of THA patients and 63% of TKA patients actually received salvaged blood, as a minimum of 200 ml blood loss was required to activate blood salvage. Only 9 patients who did not receive salvaged blood had blood loss >200 ml. Intra-operative blood loss was greater in patients who received salvaged blood than in those who did not (362.48 ± 156.15 ml, p<0.001, Table 2).

Compared with patients who did not receive allogeneic blood transfusion, those who did had a lower preoperative haemoglobin level (139.61 ± 80.66 g/l, p<0.001), less blood loss (290 ± 245 ml, p=0.03), lower rate of re-transfusion of salvaged blood (64% vs. 48%, p=0.02), lower postoperative haemoglobin level (121.65 vs. 103.46 g/l, p<0.001),
longer hospital stay (5 vs. 6 days, p=0.01), and higher complication rate (15% vs. 48%, p<0.001) [Table 3].

In univariate analysis, main predictors for allogeneic blood transfusion were female gender (odds ratio [OR]=3.5, p<0.001), age >75 years (OR=5.2, p<0.001), THA (OR=2.3, p=0.004), and preoperative haemoglobin level <120 g/l (OR=44.4, p<0.001) [Table 4]. In multivariate analysis, predictors for allogeneic blood transfusion were female gender (adjusted OR=2.8, p=0.02), age >75 years (adjusted OR=5.9, p<0.001), and preoperative haemoglobin level <120 g/l (adjusted OR=30.1, p<0.001), despite the use of intra-operative blood salvage (Table 4).

All 4 patients with a body mass index <20 kg/m² required allogeneic blood transfusion. THA was no longer a predictor for allogeneic blood transfusion, as this group had more percentage of patients with a preoperative haemoglobin level <120 g/dl and female gender.

**Discussion**

Intra-operative blood salvage avoids problems with the storage of pre-donated autologous blood and allogeneic blood transfusion, and enables re-transfusion of more efficacious oxygen-carrying red blood cells that have a higher erythrocyte viability and increased preservation of 2-3 diphosphoglycerate. It also removes contaminants and concentrates the re-transfusion volume.

In our study, patients who underwent THA were...
more likely to require allogeneic blood transfusion, probably owing to a higher percentage of patients with preoperative haemoglobin level <120 g/l and lower percentage of patients actually received salvaged blood. Patients who received allogeneic blood transfusion had a longer hospital stay and higher complication rate. Those with a preoperative haemoglobin level <120 g/l were 30 times more likely to require allogeneic blood transfusion (despite the use of blood salvage), compared with patients with a preoperative haemoglobin level >150 g/l. Thus, preoperative optimisation of the haemoglobin level to a minimum of 120 g/l is essential.11,25

Our study had several limitations. It was retrospective and predisposed to recall and selection bias. A tourniquet was not used in TKA in order to avoid initial decrease in quadriceps strength, swelling, and postoperative pain.26 Although tourniquet use decreases intra-operative blood loss, total blood loss is similar owing to decreased postoperative blood loss.27 Patients did not receive any form of tranexamic acid; this eliminated the effect of tranexamic acid as a confounder of intra-operative blood salvage. Patients were allowed to continue taking aspirin during the peri-operative period, but this increases the risk of major bleeding.28

Allogeneic blood transfusion is associated with an increasing cost of blood banking. Intra-operative blood salvage combined with preoperative optimisation of haemoglobin level, use of tranexamic acid, and individualisation of the transfusion trigger is recommended.

**CONCLUSION**

Intra-operative blood salvage is not effective in preventing allogeneic blood transfusion in patients...
with a preoperative haemoglobin level <120 g/l. It should be combined with preoperative optimisation of the haemoglobin level or use of tranexamic acid.

DISCLOSURE

No conflicts of interest were declared by the authors.

REFERENCES

1. Bierbaum BE, Callaghan JJ, Galante JO, Rabash HE, Tooms RE, Welch RB. An analysis of blood management in patients having a total hip or knee arthroplasty. J Bone Joint Surg Am 1999;81:2–10.
2. Wells AW, Mounter PJ, Chapman CE, Stainsby D, Wallis JP. Where does blood go? Prospective observational study of red cell transfusion in north England. BMJ 2002;325:803.
3. Shortt J, Polizzotto MN, Waters N, Borosak M, Moran M, Comande M, et al. Assessment of the urgency and deferrability of transfusion to inform emergency blood planning and triage: the Bloodhound prospective audit of red blood cell use. Transfusion 2009;49:2296–303.
4. Goodnough LT, Shuck JM. Risks, options, and informed consent for blood transfusion in elective surgery. Am J Surg 1990;159:602–9.
5. Hébert PC, Wells G, Tweeddale M, Martin C, Marshall J, Pham B, et al. Does transfusion practice affect mortality in critically ill patients? Transfusion Requirements in Critical Care (TRICC) Investigators and the Canadian Critical Care Trials Group. Am J Respir Crit Care Med 1997;155:1618–23.
6. Bernard AC, Davenport DL, Chang PK, Vaughan TB, Zwischenberger JB. Intraoperative transfusion of 1 U to 2 U packed red blood cells is associated with increased 30-day mortality, surgical-site infection, pneumonia, and sepsis in general surgery patients. J Am Coll Surg 2009;208:931–9.
7. Bower WF, Jin L, Underwood MJ, Lam YH, Lai PB. Peri-operative blood transfusion increases length of hospital stay and number of postoperative complications in non-cardiac surgical patients. Hong Kong Med J 2010;16:116–20.
8. Roberts WA, Kirkley SA, Newby M. A cost comparison of allogeneic and preoperatively or intraoperatively donated autologous blood. Anesth Analg 1996;83:129–33.
9. Cohen JA, Brecher ME. Preoperative autologous blood donation: benefit or detriment? A mathematical analysis. Transfusion 1995;35:640–4.
10. Lindén J, Kruskall MS. Autologous blood: always safer? Transfusion 1997;37:455–6.
11. Spahn DR. Anaemia and patient blood management in hip and knee surgery: a review of the literature. Anaesthesiology 2010;113:482–95.
12. Dalen T, Bengtsson A, Brosson B, Engstrom KG. Inflammatory mediators in autotransfusion drain blood after knee arthroplasty, with and without leukocyte reduction. Vox Sang 2003;85:31–9.
13. Hansen E, Hansen MP. Reason against the retransfusion of unwashed wound blood. Transfusion 2004;44(12 Suppl):45S–53S.
14. Widmann FK. Technical manual. 9th ed. Arlington, Virginia: American Association of Blood Banks; 1985.
15. Noon GP. Intraoperative autotransfusion. Surgery 1978;84:719–21.
16. Moonen AF, Knoors NT, van Os Jj, Verburg AD, Pilot P. Retransfusion of filtered shed blood in primary total hip and knee arthroplasty: a prospective randomized clinical trial. Transfusion 2007;47:379–84.
17. Smith LK, Williams DH, Langkamer VG. Postoperative blood salvage with autologous retransfusion in primary total hip replacement. J Bone Joint Surg Br 2007;89:1092–7.
18. del Trujillo MM, Carrero A, Munoz M. The utility of the perioperative autologous transfusion system OrthoPAT in total hip replacement surgery: a prospective study. Arch Orthop Trauma Surg 2008;128:1031–8.
19. Thomas D, Wareham K, Cohen D, Hutchings H. Autologous blood transfusion in total knee replacement surgery. Br J Anaesth 2001;86:669–73.
20. Munoz M, Ariza D, Garcia MJ, Gomez A, Campos A. Benefits of postoperative shed blood reinfusion in patients undergoing unilateral total knee replacement. Arch Orthopa Trauma Surg 2005;125:385–9.
21. Shenolikar A, Wareham K, Newington D, Thomas D, Hughes J, Downes M. Cell salvage auto transfusion in total knee replacement surgery. Transfus Med 1997;7:277–80.
22. Patient blood management guidelines: module 2 perioperative. Australian National Blood Authority, 2012. Available from: http://www.blood.gov.au/sites/default/files/documents/pbmmodule2_0.pdf.
23. Krajewski K, Ashley AK, Pung N, Wald S, Lazareff J, Kawamoto HK, et al. Successful blood conservation during craniosynostotic correction with dual therapy using procrit and cell saver. J Craniomax Surg 2008;19:101–5.
24. Munoz Gomez M, Sanchez Arrieta Y, Garcia Vallejo JI, Merida de la Torre FJ, Ruiz Romero de la Cruz MD, Eloy-Garcia JM. Pre and post-operative autotransfusion. A comparative study of hematology, biochemistry and red cell metabolism in pre-donated blood and blood from post-operative surgical drainage [in Spanish]. Sangre (Barc) 1999;44:443–50.
25. Cuenca J, Garcia-Erce JA, Martinez F, Cardona R, Perez-Serrano L, Munoz M. Preoperative haematins and transfusion protocol to reduce the need for transfusion after total knee replacement. Int J Surg 2007;5:89–94.
26. Liu D, Graham D, Gillies K, Gillies RM. Effects of tourniquet use on quadriceps function and pain in total knee arthroplasty. Knee Surg Relat Res 2014;26:207–13.
27. Jiang FZ, Zhong HM, Hong YC, Zhao GF. Use of a tourniquet in total knee arthroplasty: a systematic review and meta-analysis of randomized controlled trials. J Orthop Sci 2015;20:110–23.
28. Devereaux PJ, Mirkobrada M, Sessler DJ, Leslie K, Alonso-Coelle P, Kurz A, et al. Aspirin in patients undergoing noncardiac surgery. N Engl J Med 2014;370:1494–503.