



Assessing the Accuracy of Visual Blood Loss Estimation in Open Reduction and Internal Fixation of the Femur in a Tertiary Hospital 2019-2022: A Retrospective Review

Khristian S. Camagay, MD and Jayson B. Montano, MD

Department of Orthopedics, Region 1 Medical Center, Dagupan City, Pangasinan, Philippines

ABSTRACT

Background. Accurate estimation of intraoperative blood loss is crucial for effective treatment, particularly in orthopedic procedures such as open reduction and internal fixation (ORIF) with intramedullary nails for femoral fractures. Traditional methods rely on visual estimation, which is subjective and prone to inaccuracy.

Objective. This study aims to evaluate the accuracy of visual blood loss estimation by comparing it with laboratory-based calculations derived from hematocrit and hemoglobin levels.

Methodology. This retrospective cohort study reviewed the medical records of 115 patients who underwent ORIF with intramedullary nails at a tertiary hospital from January 10, 2019, to December 28, 2022. Blood loss was assessed using two approaches: visual estimates recorded by operating room personnel and calculations based on preoperative and postoperative hematocrit and hemoglobin values. Paired t-tests were used to compare these measurements and differences between the requested and actual number of blood bags used.

Results. Significant differences were observed between preoperative and postoperative hemoglobin ($p < 0.00001$) and hematocrit levels ($p < 0.00001$), indicating substantial blood loss. More blood bags were requested than used, with a mean difference of 0.95 ($p < 0.00001$). Visual estimates of blood loss were lower than laboratory-based calculations, with a mean difference of 55 ml ($p < 0.00001$) for hemoglobin-based EBL and 121 ml ($p < 0.00001$) for hematocrit-based EBL.

Conclusion. Visual estimates of intraoperative blood loss differ significantly from laboratory-based methods, with surgeons underestimating blood loss, and overestimating transfusion needs. This study highlights the importance of adopting more precise, laboratory-based calculations for assessing blood loss in orthopedic surgeries.

Keywords. blood loss, orthopedic procedures, hematocrit, hemoglobin, visual estimation, intraoperative blood loss estimation

INTRODUCTION

Accurate estimation of intraoperative blood loss is crucial for effective treatment, particularly in orthopedic procedures such as open reduction and internal fixation (ORIF) with intramedullary nails for femoral fractures. Traditionally, blood loss estimation relied heavily on visual assessments made by operating room personnel. However, these visual estimates are often imprecise, leading to potential discrepancies in perioperative management and blood transfusion practices. Despite this, visual estimation remains widely used due to its simplicity, immediacy, and non-reliance on equipment or calculations.

To address this issue, this study aimed to evaluate the accuracy of visual blood loss estimation by comparing it with calculations using hematocrit and hemoglobin levels. We hypothesized that visual estimates would be less accurate

ISSN 0118-3362 (Print)
eISSN 2012-3264 (Online)
Printed in the Philippines.
Copyright© 2025 by Camagay and Montano.
Received: July 21, 2025
Accepted: August 22, 2025
Published Online: October 24, 2025.
<https://doi.org/10.69472/poai.2025.22>

Corresponding author: Khristian S. Camagay, MD
Medical Officer III, Department of Orthopedics,
Region 1 Medical Center, Arellano Bani Street,
Dagupan City, Pangasinan, 2400, Philippines
Tel. No.: (075) 653-8888, (075) 515-8916, (075) 523-4103
E-mail: r1mc.orthopedicsclinic@gmail.com
ORCID: <https://orcid.org/0009-0007-6919-8552>

than laboratory-derived measurements. Improving blood loss estimation methods could enhance clinical decision-making and optimize patient outcomes during orthopedic surgery.

In other institutions and published literature, blood loss was estimated using various objective methods such as gravimetric techniques (weighing sponges and suction canisters), photometric analysis (hemoglobin concentration in fluid), and laboratory-based calculations using hematocrit or hemoglobin values. These approaches were significantly more accurate than visual estimation.¹⁻³ Many centers are moving toward more standardized and quantitative blood loss estimation protocols, especially in surgical fields where transfusion decisions are critical.

METHODOLOGY

This study was a retrospective cohort study conducted at the surgery department of a single tertiary hospital to evaluate intraoperative blood loss in patients undergoing open reduction and internal fixation (ORIF) with an intramedullary nail for femoral fractures between January 10, 2019, and December 28, 2022. The study included 115 patients selected through convenience sampling. Eligible participants were aged 18–65 years and underwent ORIF with an intramedullary implant for closed femoral fractures. Exclusion criteria included patients with blood dyscrasias, patients receiving anticoagulants, immunocompromised patients, multiply injured patients, and those who received intraoperative transfusions. Given the retrospective nature of the study, withdrawal was not applicable.

Blood loss was assessed using two methods: visual estimation, which relied on the subjective judgment of operating room personnel, and laboratory-based calculation, determined using differences in preoperative and postoperative hematocrit and hemoglobin levels. Visual estimation was defined as the intraoperative assessment of blood loss based on the appearance of surgical sponges, suction contents, and the operative field, without objective measurement. No standard training or quantification protocol was used, consistent with common surgical practice.^{1,3}

The laboratory-based estimated blood loss (EBL) was computed as:

$$EBL = EBV \times (\text{pre-op} - \text{post-op}) / \text{mean value}$$

Or

$$EBL_{Hct} = EBV \times [(Hct_{pre} - Hct_{post}) / Hct_{mean}]$$

$$EBL_{Hgb} = EBV \times [(Hgb_{pre} - Hgb_{post}) / Hgb_{mean}]$$

Where:

$$Hct_{mean} = (Hct_{pre} + Hct_{post}) / 2$$

$$Hgb_{mean} = (Hgb_{pre} + Hgb_{post}) / 2$$

using either hematocrit or hemoglobin values. Postoperative hemoglobin and hematocrit levels were collected as part of

routine blood work, primarily on the first postoperative day. Analysis of collection timing showed a mean of 1.02 days (median: 1.0 days; mode: 1 day), confirming consistent timing across the patient cohort. Data were collected from patient records, including preoperative and postoperative blood counts, the number of blood bags requested, and the actual number used.

The primary outcome measured was quantified blood loss in milliliters (mL). Secondary outcomes included the difference between the requested and actual number of blood bags used. This discrepancy was studied to assess predictive accuracy and blood resource management. The number of bags requested per case was based on surgeon preference, patient factors, and institutional transfusion protocols. To ensure data confidentiality, each patient was assigned a unique code, and data were securely stored in the hospital's records facility, accessible only to the research team.

Descriptive statistics, including means, standard deviations, and ranges, were calculated for demographic variables and blood loss measurements. Paired t-tests were used to compare preoperative and postoperative hemoglobin and hematocrit levels, and differences between requested and actual blood bags. Statistical significance was set at $p < 0.05$, and data analysis was performed using SPSS version 26.

This study adhered to the Declaration of Helsinki and received approval from the Institutional Review Board (IRB) of our institution. Informed consent was waived due to the retrospective design, as permitted by IRB guidelines.

RESULT

The study included 115 patients who underwent open reduction and internal fixation (ORIF) of the femur at our institution between January 10, 2019, and December 28, 2022. The participants had a mean age of 31 years (range: 12–79), with 83% (95) being male and 17% (20) female. The mean body mass index (BMI) was 22.92 ± 3.55 .

Preoperative and postoperative hematocrit and hemoglobin results showed a significant decrease in blood parameters, indicating substantial intraoperative blood loss. The mean preoperative hemoglobin was 122 g/L, which significantly dropped to 103 g/L postoperatively ($t = -10.13$, $p < 0.00001$). Similarly, the mean hematocrit value decreased from 38% preoperatively to 31% postoperatively ($t = -10.37$, $p < 0.00001$).

Blood bag utilization analysis revealed that the mean number of blood bags requested was 1.97, while the actual mean utilization was 1.03. This resulted in a mean difference of -0.95 ($t = -11.33$, $p < 0.00001$), highlighting a significant over-estimation of blood needs.

Comparison between visual and laboratory-based blood loss estimation methods demonstrated a clear discrepancy. Visual estimation by operating room personnel averaged 578 ml,

Table 1. Demographics of participants (N=115)

	Range	Mean	SD
Age (years)	12-79	31	14.385
Height (meters)	1.48-1.97	1.63	0.07766
Weight (kilograms)	32-85	60.59	10.1655
BMI		22.92	3.55075
Sex	Male = 95 (83%) Female = 20 (17%)		
Date of operation	January 10, 2019 – December 28, 2022		

whereas laboratory-based calculation using hematocrit levels indicated a mean blood loss of 699 ml ($t = 7.14, p < 0.00001$), and hemoglobin-based calculations showed a mean of 633 ml ($t = 7.03, p < 0.00001$).

DISCUSSION

This study highlights the inaccuracy of visual blood loss estimation compared to laboratory-based methods using hematocrit and hemoglobin levels in patients undergoing ORIF with intramedullary nails. Visual estimation significantly underestimated actual blood loss, consistent with prior research findings.^{1,3} These studies have collectively demonstrated that visual methods are prone to human error, often underestimating blood loss by 30% or more, particularly in surgeries with ongoing, concealed, or pooled bleeding.

The significant reductions in hemoglobin and hematocrit postoperatively confirm the occurrence of substantial intraoperative blood loss. These results echo the findings of previous studies,^{4,6} which emphasized that even modest drops in these parameters may signal the need for transfusion or closer hemodynamic monitoring in orthopedic patients. Such laboratory-based estimates are thus not only more precise but also clinically actionable, guiding transfusion decisions and post-op care more effectively than visual estimates alone.

Other estimation methods, such as gravimetric, photometric, and computer-assisted tools, offer more objective assessments, and their adoption is expanding in well-resourced centers.¹ These methods reduced interobserver variability and helped in real-time intraoperative decisions. However, their implementation remains limited due to cost, availability, and the training required.

The observed difference between hemoglobin- and hematocrit-based blood loss estimates (mean difference of ~66 ml) can be attributed to physiological changes such as plasma volume shifts and hemodilution after surgery. Hematocrit can be influenced more by fluid shifts, while hemoglobin levels tend to reflect actual red cell mass more accurately in acute settings. One study argues that hemoglobin-based calculations may provide a more reliable estimate of acute blood loss, especially in the immediate postoperative period.⁷

Visual estimation has remained the default method for decades due to its convenience and speed, even though its inaccuracy is well-documented. One study emphasized its widespread use, which is perpetuated by the absence of training in more objective alternatives and the lack of standardized institutional protocols.³ Despite its inaccuracy, visual estimation remains the dominant method in many institutions due to its simplicity, immediacy, and low cost. In high-volume centers and emergency scenarios, its utility lies in its speed—especially when no lab values are yet available. Without training or calibration protocols, visual estimation tends to devolve into a purely subjective guess, underscoring the need for training modules and standardized estimation frameworks.⁸

The consistent overestimation of blood bag requests—with nearly one unit per patient unused—reflects a misalignment between perceived and actual need. This has implications for resource allocation and cost-efficiency in transfusion services.⁹ Some studies suggest refining predictive models

Table 2. Preoperative and postoperative hematocrit and hemoglobin results of patients based on laboratory results (N= 115)

	Preoperative (Mean)	Postoperative (Mean)	t-value	p-value	Interpretation
Hemoglobin (g/L)	122	103	-10.134093	<0.00001	Significant
Hematocrit (%)	38	31	-10.366905	<0.00001	Significant

Table 3. Variations between requested and actual blood bag utilization during surgery (N= 115)

Requested blood bag (Mean)	Actual blood bag utilization during surgery (Mean)	Mean difference	t-value	p-value	Interpretation
1.97	1.03	-0.95	-11.333818	<0.00001	Significant

Table 4. Comparison between operating room personnel assessments and hematocrit-based calculations (N= 115)

Operating room personnel EBL in ml (Mean)	EBL by hematocrit-based calculations in ml (Mean)	t-value	p-value	Interpretation
578	699	7.13505	<0.00001	Significant

Table 5. Comparison between operating room personnel assessments and hemoglobin-based calculations (N= 115)

Operating Room Personnel EBL in ml (Mean)	EBL by Hemoglobin-Based Calculations in ml (Mean)	t-value	p-value	Interpretation
578	633	7.029	<0.00001	Significant

using laboratory data and preoperative risk scoring can optimize blood preparation practices, prevent wastage, and align with patient blood management (PBM) principles.^{10,11}

CONCLUSION

This study demonstrates that visual estimation of intraoperative blood loss by operating room personnel significantly underestimates actual blood loss when compared to laboratory-based calculations using hematocrit and hemoglobin levels. The significant drops in hemoglobin and hematocrit confirm substantial blood loss during open reduction and internal fixation (ORIF) of femoral fractures. Additionally, the notable discrepancy between the number of blood bags requested and those utilized during surgery highlights the need for more accurate blood management protocols.

The findings strongly support the adoption of laboratory-based methods, specifically hematocrit and hemoglobin calculations, for estimating intraoperative blood loss. These objective approaches provide more accurate assessments than traditional visual estimation methods, reducing the risk of underestimating blood loss and ensuring appropriate blood transfusion management. Furthermore, the overestimation of blood bag requests underscores the importance of aligning predicted blood needs with actual clinical requirements.

The primary limitation of this study is its retrospective design, which may introduce selection bias. However, the large sample size and consistent findings enhance the reliability of the results. Other limitations include potential documentation bias and reliance on routine postoperative blood draws rather than serial intraoperative monitoring. Nevertheless, the findings add to a growing body of literature advocating for objective, quantitative methods in perioperative blood loss estimation and can inform local guidelines and training programs. Future research should explore the use of real-time monitoring technologies for blood loss estimation to further enhance accuracy and patient safety in orthopedic surgery.

ACKNOWLEDGMENTS

The authors wish to express their sincere gratitude to Dr. Emelito V. Ritumalta, Department Chairman; Dr. Mario C. Castro, Training Officer and Dr. Ralph August S. Manaois, Adviser, for their invaluable guidance and support throughout this work.

STATEMENT OF AUTHORSHIP

All authors certified fulfillment of ICMJE authorship criteria.

CREDIT AUTHOR STATEMENT

KSC: Conceptualization, Methodology, Software, Formal analysis, Investigation, Resources, Data Curation. Writing – original draft preparation, Funding acquisition; **JBM:** Validation, Writing – review and editing, Visualization, Supervision, Project administration.

DATA AVAILABILITY STATEMENT

Datasets generated and analyzed are included in the published article.

AUTHOR DISCLOSURE

The authors declared no conflict of interest.

FUNDING SOURCE

None.

REFERENCES

1. Kollberg SE, Häggström AE, Lingehall HC, Olofsson B. Accuracy of visually estimated blood loss in surgical sponges by members of the surgical team. *AANA J*. 2019;87(4):277-84. PMID: 31587711
2. Gerdessen L, Meybohm P, Chooraopikayil S, et al. Comparison of common perioperative blood loss estimation techniques: a systematic review and meta-analysis. *J Clin Monit Comput*. 2021; 35(2):245-58. PMID: 32815042 PMCID: PMC7943515 DOI: 10.1007/s10877-020-00579-8
3. Rothermel LD, Lipman JM. Estimation of blood loss is inaccurate and unreliable. *Surgery*. 2016;160(4):946-53. PMID: 27544540 DOI: 10.1016/j.surg.2016.06.006
4. Carson JL, Guyatt G, Heddle NM, et al. Clinical practice guidelines from the AABB: red blood cell transfusion thresholds and storage. *JAMA*. 2016;316(19):2025-35. PMID: 27732721 DOI: 10.1001/jama.2016.9185
5. Kozek-Langenecker SA, Ahmed AB, Afshari A, et al. Management of severe perioperative bleeding: guidelines from the European Society of Anaesthesiology: First update 2016. *Eur J Anaesthesiol*. 2017;34(6):332-95. PMID: 28459785 DOI: 10.1097/EJA.0000000000000630
6. McKibben NS, Lindsay SE, Friess DM, Zusman NL, Working ZM. Methods of quantifying intraoperative blood loss in orthopaedic trauma surgery: a systematic review. *J Orthop Trauma*. 2022;36(6):e215-26. PMID: 34799543 DOI: 10.1097/BOT.00000000000002313
7. Lopez-Picado A, Albinarrate A, Barrachina B. Determination of perioperative blood loss: accuracy or approximation? *Anesth Analg*. 2017;125(1):280-6. PMID: 28368940 DOI: 10.1213/ANE.0000000000001992
8. Athar MW, Abir G, Seay RC, Gui N, Butwick A, Carvalho B. Accuracy of visual estimation of blood loss in obstetrics: an observational simulation cohort study. *Int J Obstet Anaesth*. 2022;50:103539. PMID: 35397264 DOI: 10.1016/j.ijoa.2022.103539
9. Kersjes E, Smith LB. How should decision science inform scarce blood product allocation? *AMA J Ethics*. 2019;21(10):E852-7. PMID: 31651384 DOI: 10.1001/amajethics.2019.852
10. Frank SM, Savage WJ, Rothschild JA, et al. Variability in blood and blood component utilization as assessed by an anesthesia information management system. *Anesthesiology*. 2012;117(1): 99-106. PMID: 22531332 DOI: 10.1097/ALN.0b013e318255e550
11. Goodnough LT, Shander A. Patient blood management. *Anesthesiology*. 2012;116(6):1367-76. PMID: 22487863 DOI: 10.1097/ALN.0b013e318254d1a3

Disclaimer. All articles and materials published in PJO are solely those of the authors. Statements and opinions expressed by authors do not represent those of the editor/s of the Philippine Journal of Orthopaedics or of its publisher, the Philippine Orthopaedic Association.