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ORIGINAL ARTICLE

Relationship Between Surgery Timing and Hidden Blood Loss in Proximal Femoral Nailing of Pertrochanteric Fractures in Elderly Patients: A Cross-sectional Study*

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ABSTRACT

Objectives. Pertrochanteric fractures, commonly incurred by the elderly from low-energy falls, require surgical management. Visible blood loss in the perioperative period is inconsistent with the big drop in hemoglobin seen postoperatively. This discrepancy is attributed to the hidden blood loss (HBL), which must be anticipated in anemia management. This study aimed to determine if the amount of HBL in elderly patients with pertrochanteric femur fractures treated with short proximal femoral anti-rotation nailing (PFNa) is affected by the delay in time to surgery.

Methodology. This is a detailed cross-sectional study from a single institution. Two hundred and ten patients admitted and operated on from January 2017 to December 2019 at an orthopedic specialty hospital were included in the study. Patient's age, sex, AO classification, weight, height, operative time, and hematocrit levels on admission, within 7 days before surgery and immediately postoperatively; visual blood loss and blood transfused were reviewed and retrieved from medical records. Cases were grouped into early (<30 days) or late (≥30 days) surgery groups based on the time from injury to surgery. Total blood loss and hidden blood loss were computed based on the data.

Results. There was no significant difference in the demographic and clinical characteristics of patients in both groups. Mean HBL was 113.65 mL (±99.25 mL) in the early surgery group and 95.32 mL (±111.79 mL) in the late surgery group. Mean HBLs were 31.47% and 27.88% of the total blood loss computed for the early and late surgery groups, respectively. Using an independent t-test, we noted no significant difference in the HBLs between the groups (p = 0.22).

Conclusion. Delay in treatment of pertrochanteric fractures fixed with short proximal femoral anti-rotation nailing did not significantly affect the amount of hidden blood loss. However, the computed hidden losses, which make up a large percentage of the total blood loss, should be considered in the postoperative management of anemia.

Keywords. blood loss, surgical, operative time, treatment delay, proximal femur fractures, fracture fixation, intramedullary, cross-sectional study

INTRODUCTION

Pertrochanteric femur fractures are a common injury in the elderly population. Due to a globally aging population, hip fractures are estimated to number around 2.56 million by the year 2050.[1] Innovations in technology accompany this upsurge in cases. Most fractures are treated using either a proximal femoral nail anti-rotation (PFNa) or a dynamic hip screw (DHS). Although there is still no gold standard, fixation with a PFNa has grown in favor among surgeons because it allows the patient to ambulate and bear weight on the affected extremity early without fearing implant-related complications.[2-4]

Perioperative blood loss comprises the volume lost during surgery plus the amount collected in post-surgical drains.

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However, this amount does not correlate with the post-operative drop in hemoglobin.[5] Sehat et al., – in an experiment comparing visible blood loss and total blood loss in arthroplasty cases – proposed that the difference is accounted for by hidden blood loss (HBL).[6] Other sources of loss include those from the initial trauma, intraoperative extravasation into the soft tissues, or other blood loss incurred during hospitalization. In recent years, there has been growing interest in defining HBL, especially in the aged population. If left untreated, HBL may aggravate pre-op comorbidities and lead to anemia.[5] Most studies have focused on quantifying HBL[7] or determining its associated risk factors,[8] but to date none have studied time from trauma to surgery as a variable.

A systematic review and meta-analysis by Klestil et al.,[9] noted that hip fractures treated within 48 hours had a lower risk for mortality and perioperative complications. This is, however, not observed in our local setting. Delays to surgery are common due to socio-economic factors and scant resources (including blood products). Whatever the reason for the delay, we still push for surgery to improve hip function and reduce complications when compared to nonoperative treatment.[10] Computing for the HBL may help in estimating the amount of blood products needed to manage postoperative anemia.[11] This study aims to determine if HBL in elderly patients with pertrochanteric fractures treated by PFN is affected by delay in time to surgery.

METHODOLOGY

This was a detailed cross-sectional study. Exemption from ethics review was granted by the institution's ERB before starting data gathering (POCERB 2020-01-002). The data analyzed was limited to non-identifiable figures, waiving the need for informed consent. The STROBE cross-sectional reporting guidelines[12] were used as a checklist in making this study.

A review of the surgical census and medical records was done to collect data about patients with pertrochanteric fractures treated by closed reduction and short proximal femoral anti-rotation nailing (PFNa). Patients aged 60 years old and above who were seen at the ER, admitted, and operated on from January 2017 to December 2019 were included. Excluded from the study were patients with 1) fractures of other extremities surgically treated during the same operative time, 2) pathologic fractures, 3) patients with hematologic or GI comorbidities, and 4) patients also taking blood thinners or were given Tranexamic acid.

The sample size was calculated based on the estimation of population proportion for pertrochanteric femur fractures. Assuming that the incidence of hip fractures in the elderly population is 18%,[13] and using a level of significance equal to 5%, the sample size required was 196 patients.

The following data were obtained from the medical and radiographic records of patients: age, sex, height, weight, AO classification, time from initial trauma to surgery, total operative time, intraoperative visible blood loss from the operative record, and complete blood counts done on admission, within 7 days before surgery and up to 72 hours post-surgery. Patients were classified into either early (time from injury to surgery <30 days) or late (≥30 days) surgery group.

The patient's total blood volume (PBV) was computed using the formula as reported by Nadler et al.,[14] as follows:

$$PBV, \text{ in liters} = K1 \times h^3 + K2 \times w + K3$$

where h = height in meters, and w = weight in kg,
Men: K1 = 0.3669, K2 = 0.03219, K3 = 0.6041,
Women: K1 = 0.3561, K2 = 0.03308, K3 = 0.1833

After computing the total blood volume, we computed the estimated blood loss, and the peri-operative hidden blood loss, using the formula by Gross,[15] as follows:

$$\text{Estimated blood loss (mL)} = PBV \times [(Hct_{adm} - Hct_{pod1}) / Hct_{ave}] \times 1000$$

$$\text{Total perioperative blood loss (mL)} = \text{estimated blood loss} + \text{blood transfused}$$

$$\text{Perioperative HBL (mL)} = \text{total perioperative blood loss} - \text{intraoperative visible blood loss}$$

Where Hct_{adm} was the hematocrit count done during admission, Hct_{pod1} was the hematocrit count on the first postoperative day, and Hct_{ave} was the average of all hematocrit counts done from admission to discharge.

The data was encoded in Microsoft Excel and analysis was done using SPSS 20 software. Data was described as mean ± standard deviation. Comparison of the demographic and clinical characteristics was performed using the independent sample t-test. A confidence interval of 95% was used to determine statistical significance.

RESULTS

A total of 210 patients were included in the study. One hundred and thirty-five patients were categorized in the early surgery group, while 75 patients were categorized in the late surgery group.

The mean age for the early surgery group was 77 years old and 76 years old for the late surgery group (Table 1). Most patients were women. Most of the patients were classified under AO 31-A1.2 (2-part pertrochanteric fracture). The operative duration averaged 73.17 minutes in the early surgery group and 72.64 minutes in the late surgery group. The mean visual blood loss for the early surgery and late surgery groups were 247.37 mL and 245.33 mL, respectively. The averages of hematocrit levels taken on admission, pre-operatively within 7 days, and immediately postoperatively are listed in the table.

There were no significant differences between the two groups in terms of age, sex, AO classification, operative duration, HCT levels, intraoperative visual blood loss, postoperative blood transfused, and total blood loss.

Our results showed that there was no significant difference noted between the two groups in terms of peri-op HBL (p = 0.22) (Table 2). The mean peri-operative HBL of patients with delayed time to surgery was 95.32 ml compared to 113.65 ml of patients with early time to surgery.

DISCUSSION

Increased perioperative blood loss may lead to many complications and a poor prognosis, especially in the elderly population. Therefore, it is important to identify the causes of perioperative blood loss. Hidden blood loss accounts for a high percentage of the total perioperative blood loss in patients with pertrochanteric fractures.[5] If HBL is disregarded, it may lead to anemia or low blood volume. Patient-blood management programs resulted in positive outcomes for patients under orthogeriatric care. It showed a reduction in complication and mortality rates, as well as improvement in functional recovery in the transfused patient group.[16] Foss[17] also reported that uncorrected anemia is associated with decreased mobility and an increased 30-day mortality and length of hospital stay in surgically treated hip fracture patients. Higher hemoglobin levels post-op were also shown to be related to a shorter hospital stay and lower odds of readmission.[18] This fueled the increased interest in quantifying hidden blood loss and studying its risk factors.

Hidden blood loss was computed to be nearly 75% of total blood loss according to Yu et al.,[19] or 86.8% to 89.4% according to Li et al.,[20] using the same formula. In this paper, we computed the mean HBL of 210 patients to be 107.10 mL comprising 30.27% of the mean total blood loss. While published literature reports figures twice as large as ours, there is no denying that HBL makes up a sizeable amount of total blood loss. One of the limitations of this study is the inconsistency in measuring visible blood loss, given that it is a retrospective study. The estimation of visible blood loss may vary from person to person, thus one of the recommendations for a future prospective paper is the creation of a protocol for standardized measurement.

Most available literature on hidden blood loss in surgically treated pertrochanteric fractures excluded patients whose surgeries are delayed. Our "early surgery" setting happens at an average of 18 days after the injury, which is a stark contrast to the immediate surgery done at 1-3 days post-injury in published literature.[2-4,7-8,11] This delay is brought about by many factors, including patient socio-economic factors and limited hospital resources.

Our results cannot therefore be compared side-by-side to available studies. Yu et al.[16] noted an HBL of 272.2 mL (± 7.6 mL) in their subset of patients who underwent fixation using a PFNa. A similar study by Yang et al.,[21] computed HBL of 787.7 mL (± 250.9 mL) in the group fixed with a PFNa. Tian et al.,[11] computed HBL to be around 326 to 596 mL, depending on the need for postoperative blood transfusion. Our computed HBLs were 113.65 mL (± 99.25 mL) for the early surgery and 95.32 mL (± 111.79 mL) for the late surgery groups, with no significant difference between the two groups.

Table 1. Demographic and clinical characteristics of patients by time from injury to surgery (n=210)

	Early Group (n=135)	Delayed Group (n=75)	p
Age in years (mean, range)	77.00 ± 8.82 (60 to 96)	76.29 ± 7.71 (60 to 94)	0.56 (NS) †
Sex			0.66 (NS) ǂ
Male	23 (17.0%)	11 (14.7%)	
Female	112 (83.0%)	64 (85.3%)	
AO Classification			0.38 (NS) ǂ
AO 31-A1.2	70 (51.9%)	37 (49.3%)	
AO 31-A1.3	27 (20.0%)	21 (28.0%)	
AO 31-A2.2	26 (19.3%)	9 (12.0%)	
AO 31-A2.3	12 (8.9%)	8 (10.7%)	
Operative duration in mins (mean, range)	73.17 ± 27.84 (25 to 148)	72.64 ± 27.88 (26 to 140)	0.89 (NS) †
Hct (admission) (mean, range)	0.35 ± 0.05 (0.23 to 0.46)	0.33 ± 0.05 (0.20 to 0.46)	0.07 (NS) †
Hct (pre-operatively) (mean, range)	0.35 ± 0.04 (0.28 to 0.54)	0.35 ± 0.03 (0.28 to 0.46)	0.80 (NS) †
Hct (immediate post-op) (mean, range)	0.32 ± 0.04 (0.18 to 0.42)	0.32 ± 0.03 (0.22 to 0.42)	0.60 (NS) †
Visual blood loss (mL), mean	247.37 ± 100.38	245.33 ± 110.03	0.89 (NS) †
Blood transfused (mL), mean	328.36 ± 143.85	327.46 ± 169.62	0.96 (NS) †
Total blood loss (mL), mean	360.85 ± 150.08	341.18 ± 173.88	0.39 (NS) †

*p>0.05 – Not Significant; p≤0.05 – Significant
†T-test; ǂChi-square test

Table 2. Comparison of the peri-operative HBL between the two groups

	Early Group (n=135)	Delayed Group (n=75)	p*
Periop HBL (ml), Mean ± SD	113.65 ± 99.25 (31.48%)	95.32 ± 111.79 (27.88%)	0.22 (NS)†

*p>0.05 – Not Significant; p≤0.05 – Significant

In theory, the absence of fracture hematoma, resolution of third-spacing post-injury, and optimized medical status may account for the lower computed HBL. However, we do not have supporting literature for this, owing to the lack of studies on delayed treatment.

This study has its limitations, such as the study design, the lack of an electronic medical database, and the limited resource setting of the institution. The authors suggest pursuing a prospective study to control confounding factors, such as measurement of visible blood loss, and uniform date of blood extraction for CBC results up to the third day postoperatively. Future studies may reveal a relationship between time to surgery and the amount of blood loss.

CONCLUSION

In the setting of delayed treatment of elderly patients with pertrochanteric femur fractures fixed with short proximal femoral antirotation nailing, the amount of hidden blood loss is not significantly affected by the timing of surgery. However, this hidden blood loss still makes up almost a third of the total blood loss and should be anticipated in the management of postoperative anemia.

STATEMENT OF AUTHORSHIP

All authors certified fulfillment of ICMJE authorship criteria.

AUTHORS DISCLOSURE

The authors declared no conflict of interest.

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