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A Study To Quantify The Non-Surgical Blood LossIn Femur Fractures.

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ABSTRACT

To quantify the expected non-surgical blood loss for proximal femur fractures using haemoglobin values. A retrospective analysis of patients sustaining proximal femur fractures was performed during the study period. Patients were 30 year of age, had sustained intertrochanteric, subtrochanteric , or femoral neck fracture and had haemoglobin values documented at admission and after 12 hr but before surgery . Patients with concomitant fractures, other haemorrhagic injuries, or blood transfusions before their second haemoglobin result were excluded. A multivariate linear regression model constructed to evaluate the predictive ability of age, sex, BMI, number of comorbidities, fracture type, anticoagulation/antiplatelet therapy, admission haemoglobin, timing of surgical intervention and changes in electrolyte levels on subsequent haemoglobin values. Haemoglobin changes were compared between intertrochanteric, subtrochanteric, and femoral neck fractures and anticoagulant therapy types. 120 patient were included . The mean age was 78.9 ± 9.5 years . Almost 50% of subjects were using anticoagulation therapy. The mean drop in haemoglobin was1.4 ± 1.03 g/dL. The multivariate linear regression model had statistically significant predictive ability ($R= 0.91$ and $p < 0.001$). Independent predictors of haemoglobin decrease were number of comorbid conditions ($p = 0.03$), admission haemoglobin reading ($p < 0.001$), fracture type ($p= 0.02$) and time from admission to surgery ($p=0.02$). Intertrochanteric fractures demonstrated the largest haemoglobin drops. Anticoagulation therapy had no effect on subsequent haemoglobin. Proximal femur fractures causes a significant amount of blood loss prior to surgical intervention. Patients at particular risk include those with comorbidities, intertrochanteric fractures, low admission haemoglobin values, and increased time to surgery. The identification of demography, fracture type and treatment characteristics may help surgeon identify patients at the greatest risk for blood loss and provide more effective perioperative care.

Keywords: Femur fracture, surgery, hemoglobin

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INTRODUCTION

The blood loss observed during surgery is less when compared to the actual blood loss during elective hip and knee replacement surgery [1, 2]. Patients suffering from hip fractures are usually elders who are further more susceptible to anaemia and hypovolemia [3, 4]. There is unappreciated blood loss also due to haemorrhagic internal lesions. Previous studies have reported only the observed amount of intra-operative bleeding and the blood collected in drains [5, 6]. The patient'sintravascular red blood cell content can be assessed through haemoglobin levels. There are various factors affecting the haemoglobin lab value, it is still widely used as a surrogate measure of blood loss [7-10]. Hip surgery results in reduction of haemoglobin levels and post operatively, the drops up to four points have been documented in the literature [11, 12]. However, the portion of blood loss which is attributable to fracture bleeding only remains ill-defined.

There is a substantial drop in haemoglobin even without surgery which is termed as hidden blood loss [9-11]. It's seen even in other orthopaedic procedures like total joint arthroplasty [12, 13]. Most of the blood loss in hip fractures patients tends to occur preoperatively [18]. Preoperative anaemia poses a significant actor for perioperative death [14-18] and need for blood transfusions [19, 20]. Alternatively, higher postoperative Hgbs have been associated with better overall outcomes[21]and shorter hospital stays [22].

So, estimation of quantifying the expected blood loss prior to surgery may help surgeons to plan adequately for surgery. Hence, the present study was carried out to identify risk factors predictive of higher blood loss. Secondary objectives were to quantify the expected blood loss for various proximal femur fractures, independent of surgery (occult blood loss).

METHODS

sample size of 120 patients was selected to achieve 80% of the power, after obtaining ethical committee approval. A retrospective analysis of demographic data, patient health status, lab values and timing of surgery was performed for sustained proximal femur fractures patients during the study period. The electronic medical record was queried for qualifying patient chartsusing ICD 10 codes corresponding to femoral neck fractures (S72.00), intertrochanteric fractures (S72.10), and subtrochanteric fractures (S72.2). These included OTA fracture classification type 31A1.2-3, 31A2.2-3, and 31A3.1-3, 31B1.1-3, 31B2.1-3, and 31B3.1.

Inclusion criteria

- Age > 30 years
- Sustained proximal fracture
- Haemoglobin values documented

Exclusion criteria

- Concomitant long bone fracturesHaemorrhagic injuries
- Blood transfusions prior to second Hgb

A multivariate linear regression model was constructed to evaluate the predictive ability of age,sex, BMI, number of comorbidities (chronic kidney disease, diabetes mellitus, congestive heart failure, anaemia), fracture type (intertrochanteric, sub-trochanteric, femoral neck), anticoagulation/antiplatelet therapy, admission haemoglobin value, and change in electrolyte levels (sodium, potassium, chlorine), and time from admission to surgery on the subsequent haemoglobin value. Changes in electrolyte levels were used as surrogate measures of dehydration and taken at the same time as each haemoglobin measure if available.

Additionally, changes in haemoglobin were compared between fracture types post-hoc comparisons in haemoglobin changes were performed between fracture types (femoral neck, intertrochanteric, and sub-trochanteric) and between anticoagulation therapies with Welch's tests. Anticoagulation therapies were classified into antiplatelets, Vitamin K antagonists, factor Xa inhibitors, direct thrombin inhibitor, and low molecular weight heparins (LMWH), or none.

RESULTS

A total of 120 patients (35 males, 85 females) were eligible for the study. The mean age was 78.9 ± 9.5 years (range 50-101 years). The mean BMI was 28.0 ± 7.4 (range 15-49). Seventy- five patients (62.5%) sustained femoral neck fracture , 35 (29.1%) had intertrochanteric fracture , and 10 (8.3%) had subtrochanteric fractures . Nearly half of subjects (60 of 120) were using anticoagulation or antiplatelet therapy prior to admission. The average number of comorbidities per patient was 0.6 ± 0.91 (range 0-4, Table 1). There was a mean drop in haemoglobin of 1.4 ± 1.03 g/dL (range -1.3-5.2 g/dL). Five patients experienced a non-transfusion-related increase in haemoglobin. Patients requiring operative intervention experienced an additional mean Hgb drop of 1.6 g/dL for a mean post-operative Hgb level of 9.6 g/dL (Table 2). Twenty-five patients (21.0%) required a blood transfusion, all of whom were operatively managed (Table 2).

Demographic details of the patients are mentioned in table 1 .

The multivariate linear regression model appeared to have statistically significant predictive ability overall with an R = 0.91 and $p < 0.001$. Individual variables that had statistically significant predictive ability on subsequent haemoglobin values were number of comorbid conditions ($p = 0.03$), admission haemoglobin reading ($p < 0.001$), fracture type ($p = 0.02$), and time from admission to surgery ($p = 0.02$). Age, sex, BMI, number of comorbidities , changes in electrolyte levels, and anticoagulation did not appear to be predictive of subsequent haemoglobin values (Table 3).

A post-hoc test of haemoglobin decrease by fracture type revealed decreases of 1.0 ± 0.2 g/dL, 1.7 g/dL, and 1.4 g/dL for subtrochanteric, intertrochanteric, and femoral neck fractures respectively. Heterogeneity of variances secondary to unequal sample sizes between fracture types required utilization of a Welch's test in place of a one-way ANOVA test. The difference in haemoglobin drop was statistically significant ($F[2,38.4] = 5.9$, $p = 0.005$). A post-hoc Tukey test revealed that the mean haemoglobin drop was statistically significant only between inter- trochanteric fractures and femoral neck fractures ($p = 0.005$), where intertrochanteric fractures had a larger drop in haemoglobin than femoral neck fractures from admission (mean difference0.5 g/ dL, 95% CI [0.1-1.08]) (Table 4).

A Welch's test was also performed to evaluate changes in Hgb between patients utilizing anticoagulation/antiplatelet therapies and patients that did not. There was no statistically significant difference in mean Hgb drops between patients taking Vitamin K antagonists, factor Xa inhibitors, direct thrombin inhibitors, LMWH, antiplatelet therapies, and patients not taking any anticoagulation or antiplatelet therapies. Mean Hgb drops for each group are shown in table5

Table 1: Patient's demographics

Factor	Value	Percentage/ range
Age	78.9 ± 9.5	50-101
Sex		
Male	35	29.1%
Female	85	70.8%
BMI	28.0 ± 7.4	15-49
Fracture type		
Femoral neck	75	62.5%
Intertrochanteric	35	29.1%
Subtrochanteric	10	8.3%
Comorbidities	10	8.3%
Anemia		
CKD	18	15.0%
CHF	24	20%
DM	21	17.5%
Vitamin K	5	4.1%
Anticoagulation use	60	50%
Direct thrombin inhibitors	4	3.3%

LMWH		
Electrolytes		
Sodium	136 ± 6.0	N/A
#1	136 ± 5.1	120-165
#2	133±4.1	124-165
Potassium	0.12±0.3	N/A
#1	4.1±0.52	2.5-5.6
#2	4.5±0.43	3.4-5.1
Chloride	-1.8±3.1	N/A
#1	100±5.9	83-131
#2	101±4.7	88-140

Table 2: Patient's outcomes

	Mean	Range
Conservatively treated		
Hgb #1 (g/dL)	10.9 ±1.9	7.7-14.1
Hg#2(g/dL)	10.8 ± 1.5	7.0-12.9
Surgically treated		
Hg#1	11.9± 1.6	9.0-15.9
Hg#2	10.8 ± 1.91	6.6± 1.8
Hgb post op (g/dL)	9.4 ± 1.6	5.5-12.1
EBL (ml)	139 ± 118.5	5-671
Surgery time (hrs)	1.5 ± 0.91	0.4-3.4
Admit to surgery (hrs)	28.7 ± 19.1	12.9-138
Transfusion	22 (18.3%)	N/A
Post-op Hgb (g/ dl)	7.1 ± 1.9	5.2-10

*EBL- Estimated blood loss

Table 3: Results of multivariate regression analysis

Variables model	B	Significance
Constant	0.041	0.91
Age	0.001	0.97
Sex	0.21	0.21
BMI	0.01	0.45
Comorbidities	0.26	0.03*
Fracture type	-0.47	0.02*
Anticoagulation	-0.023	0.68
Admission haemoglobin	0.90	<0.001*
Time (Admit to OR)	-0.011	0.02
Change in sodium	-0.016	0.73
Change in potassium	-0.27	0.18
Change in chloride	0.04	0.08
Overall model	R=0.89	<0.001*

*indicates statistical significance

Table 4: Relevant comparisons by fracture type.Demographic characteristics andoutcomes were compared.

Fracture rate, N %	Age	Sex	BMI	Blood thinners	Anemia	CHF	CKD	DM
Femoral neck	81 ± 10.6	57 F (76)	24 ± 5.3	42 (55.3)	6 (7.9)	9 (11.8)	15 (19.7)	13(17.1)
Intertrochanteric	80 ± 11.3	28 F (80)	26 ± 7.5	17 (47.2)	4 (11.1)	8 (22.2)	7 (19.4	8 (22.2)
Subtrochanteric	83 ± 11.0	10 (100)	27 ± 9.6	4 (57.1)	0 (0)	2 (28.6)	0 (0)	3 (42.9)
P values	0.79	0.23	0.16	0.74	0.59	0.23	0.41	0.24

	Hgb1	Hgb2	Hgb change	EBL	Surgery length	Hgb Post op
Femoral neck	12.5 ± 1.6	11.5 ± 1.4	1.0 ± 0.2	147± 25.0	1.5± 0.79	10.1 ± 1.64
Intertrochanteric	12.1 ± 1.5	10.4 ± 1.5	1.7	117 ± 66.2	1.1 ± 0.43	8.7 ± 1.3
Subtrochanteric	10.9 ± 1.5	9.5 ± 1.5	1.4	165.0 ± 139.7	1.1± 1.00	8.6 ± 1.57
P values	0.03*	<0.001*	0.005*	0.33	0.027*	0.001*

EBL: Estimated blood loss, *indicates statistical significance

Table 5: Difference in haemoglobin readings between anticoagulation therapies.

	N (%)	Mean±SD
Therapy type		
None	60(50%)	1.5±1.01
Factor Xa inhibitors	34 (28.3%)	1.2±0.9
Antiplatelet	15 (12.5%)	1.3±1.04
Vitamin K antagonists	5 (4.1%)	1.4±1.58
Direct thrombin inhibitors	3 (2.5%)	1.5±0.26
LMWH	3(2.5%)	1.7±1.07
Over all comparison	F(5,14.2) ¼ 0.6	P=0.61

DISCUSSION

The occult loss of from blood from fracture after injury and/or following surgery has been a matter of debate. Poorer functional scores are associated with perioperative anaemia [23]. A study from Denmark addressing the ‘hidden’ blood loss after hip fracture surgery had unaccounted blood losses anywhere from 547 mL (screws/pins) to 1437 mL (intramedullary hip nail and screw) [14]. Hidden blood loss in connection with surgery for hip fracture was substantial, with an excess of up to six times that observed during the surgical procedure. The amount of blood loss depends on type of procedures being performed with the greatest losses occurring with the use of a dynamic hip screw and intramedullary hip nail and screw. Medical complications tends to occur more with increasing blood loss. Also, the length of hospitalization would increase. Hidden blood loss has been evaluated in elective knee and hip replacement by similar methods to ours, and has been found to be 100% and 30% of the observed loss, respectively [1].

The results of the current study indicate that patients sustaining inter-trochanteric fractures experienced the greatest decrease in haemoglobin 1.74 g/dL followed by sub-trochanteric 1.4 g/dL and then femoral neck fractures 1.0 g/dL ± 0.2. Similar findings were obtained by Smithet al., who reported on 118 patients sustaining proximal femur fractures with a delay to surgerygreater than 48 h. However, they could not differentiate between intertrochanteric and sub- trochanteric fractures or include anaemic patients, they found an average Hgb drop of 2.02 for intra-capsular fractures and 1.5 for extra-capsular fractures [18]. Kumar et al. reviewed 127 patients with proximal femur fractures and reported preoperative drops in Hgb of 1.1 g/dL for intertrochanteric, 2.2 g/dL for sub-trochanteric, and 0.7 g/dL for femoral neck fractures [21]. Thedifferentiating feature of the current study is that it included patients with pre-existing anaemiaand those on anticoagulation treatments.

Increased time from admission to surgery was also predictive of an increased drop in haemoglobin (p ¼ 0.01). This can be explained owing to the fact that, there is increased blood loss following fracture until it is reduced and stabilized. Hence timing of hip fracture surgery and earlier intervention is of added advantage.

Several studies have found decreased mortality for patients undergoing surgery within 12 and24 h [24, 25] and fewer complications such as pressure sores and length of hospital stay. Furthermore, Want et al. found that increased time from admission to surgery resulted in larger postoperative haemoglobin drops in intertrochanteric fractures treated with cephalo-medullarynailing [25]. Still, other studies have concluded that delaying surgery up to 48 h has no effect on patient outcomes [26, 27]. Our results support earlier operative intervention.

It is interesting to note statistically significant post-operative Hb values between fracture types, specifically the lower post-operative haemoglobin values associated with femoral neck fractures. In the current study, we repaired femoral neck fractures exclusively with anterior- approach hemi-arthroplasty, as opposed to intertrochanteric and sub-trochanteric fractures which are repaired with cephalo medullary nail placement. Because hemi arthroplasty is generally more costly with respect to blood loss than cephalo- medullary nailing. It stands to reason that there is another significant source of blood loss associated with these fractures because patients did not differ with respect to any other demographic characteristics (Table 4), hidden blood loss is a probable explanation for this observation. We additionally found that anticoagulation/antiplatelet therapy was not an independent predictor of preoperative blood loss. This finding was lacking in previous studies [18, 21, 28]. Morbidity and mortality associated with decreased Hb values in patients has been well established [29, 30, 31]. Thus, closely monitoring Hb values facilitates improved patient outcomes, and provides a reliable estimation of blood loss without complex calculations [14, 28, 32]. There was no changes in sodium, potassium, or chloride in the present study and hence we predict them not to be risk factors for increased blood loss.

CONCLUSION

Proximal femur fractures are traumatic events resulting in immediate and significant blood loss. The blood loss secondary to the fracture itself cannot be overlooked as these fractures may occur in older persons with decreased vital reserves. Its been shown that amount of blood loss in proximal femur fractures is statistically significant. In addition, the identification of demography , fracture, and treatment characteristics may help surgeons identify patients at the greatest risk for blood loss, and consequently, provide more effective perioperative care .

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