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ANALYSIS OF THE HEMOGLOBIN LEVEL DROP IN PATIENTS WITH HIP FRACTURE AFTER ADMISSION

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SUMMARY – The studies that evaluated blood loss during hip surgery found a relatively small loss that does not explain the large hemoglobin drop postoperatively. The aim of this study was to determine the fall in hemoglobin level after admission and rehydration in patients with hip fractures and to identify the patients that need blood transfusion. This retrospective study included data on 374 patients with hip fracture with surgery delayed by more than 24 hours and complete blood count repeated prior to surgery after fluid resuscitation for a minimum of 24 hours. The hemoglobin level (g/L) was analyzed after admission and after rehydration. The results were compared by Student's t-test. The mean hemoglobin drop was 6.1 g/L, 12.05 g/L and 16.52 g/L for capsular, pertrochanteric and subtrochanteric fractures, respectively. This hemoglobin drop was statistically significant in all fracture types. The significant drop of preoperative hemoglobin should be taken in consideration when planning transfusion for hip fracture patients. Collection of blood sample after rehydration preoperatively would enable prompt diagnosis and treatment of anemia in these patients, along with proper transfusion planning and cross-matching.

Key words: *Blood transfusion; Hemoglobins; Hip fractures; Fluid therapy; Anemia*

Introduction

The incidence of hip fractures in adults aged 65 years and older is estimated to be 818/100,000 inhabitants. Women are affected 2 to 3 times more frequently than men[1,2]. Mortality after hip fractures remains significant, 11%-23% at six months and 22%-33% at one year of injury. This mortality has remained essentially unchanged over the last four decades[3,4].

According to Laulund *et al*., low admission hemoglobin (Hb) was found to be a valid mortality predictor in these patients[5]. Also, the study by Bhaskar and Parker showed a significant increase in one-year mortality in anemic patients, especially those with Hb 80-100 g/L on admission for hip fracture[6]. Higher postoperative Hb has been associated with better early functional recovery, shorter length of stay, and lower readmission rates[7,8]. Several authors have identified on-admission Hb level as the most useful predictor of transfusion risk[9]. In their study of 546 hip fractures, Foss and Kehlet found average intraoperative blood loss of 200 mL for hemiarthroplasty and dynamic hip screw (DHS) surgery, and 50 mL for screw fixation[9]. According to Jones *et al*., the blood loss of 250 mL would result in 10 g/L drop in Hb level[10]. On the contrary, Khan *et al*. report a large Hb drop postoperatively (31 g/L for pertrochanteric and 18 g/L for capsular fractures) compared with on-admission Hb[11]. The Hb drop after admission prior to surgery could depend on the degree of dehydration and rehydration after admission, as well as on the additional amount of blood lost at the fracture site.

The aim of this study was to determine the preoperative fall in Hb level after rehydration in patients

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Table 1. Hemoglobin results in hip fracture patients

Fracture type		On-admission Hb (g/L)	Preoperative Hb (g/L)	Hb drop (g/L)
All (N=374)	Min	82	72	-21
	Max	160	152	46
	Mean	118.99	108.22	10.77
	SD	14.18	14.87	11.25
Intracapsular (n=112)	Min	90	83	-21
	Max	160	152	26
	Mean	124	117.90	6.10
	SD	13.99	12.55	8.28
Pertrochanteric (n=220)	Min	82	72	-13
	Max	154	145	46
	Mean	116.82	104.77	12.05
	SD	13.59	13.89	11.36
Subtrochanteric (n=42)	Min	92	76	-12
	Max	155	125	38
	Mean	117	100.48	16.52
	SD	14.63	13.16	13.24

Min = minimum values; Max = maximum values; SD = standard deviation; Hb = hemoglobin; Hb drop = on-admission Hb value minus preoperative Hb value

with hip fractures and to identify the patients requiring intra- or postoperative blood transfusion. Our hypothesis was that the Hb level drop occurs preoperatively after admission.

Patients and Methods

This retrospective single-center study included data on 374 patients with hip fracture. The patients entered the study when the surgery was delayed by more than 24 hours and complete blood count was repeated prior to surgery after fluid resuscitation for a minimum of 24 hours. The resuscitation followed the "500 mL saline every 8 hours" schedule. Patients were excluded when they required blood transfusion prior to collection of second blood specimen, had documented anemia, were taking anticoagulants, or another source of hemorrhage was identified (another injury).

Data on age, sex and fracture type (intracapsular, pertrochanteric or subtrochanteric fracture) were collected. Hemoglobin level (g/L) was analyzed after admission and after rehydration.

Fractures classified as AO/OTA (Orthopaedic Trauma Association) proximal femur type 31-B (fractures of the femoral neck, including 31-B1, 31-B2 and 31-B3) were grouped as intracapsular fractures[12]. Fractures of the trochanteric region proximal to the line passing transversely through the lower end of the lesser trochanter were grouped as pertrochanteric fractures (classified by OTA as trochanteric fracture types 31-A1, 31-A2 and 31-A3). If the fracture was in the area from lesser trochanter to 5 cm distally (with or without associated pertrochanteric component), it was grouped as subtrochanteric fracture (OTA classification types 32-A(1-3).1, 32-B(1-3).1 and 32-C(1-3).1). Preoperative and postoperative x-rays were analyzed to define fracture type in each patient.

This clinical study was performed in accordance with ethical standards of the 1964 Helsinki Declaration, as revised in 2013. It was a retrospective study, and formal consent is not required for this type of study in our institution.

Student's matched pair t-test was used on statistical analysis, and $p<0.05$ was considered significant. One-way ANOVA was used to test differences in the characteristics of the three study groups.

Results

The study inclusion criteria were met by 374 patients (112 intracapsular, 220 pertrochanteric and 42 subtrochanteric fractures). All patents were admitted

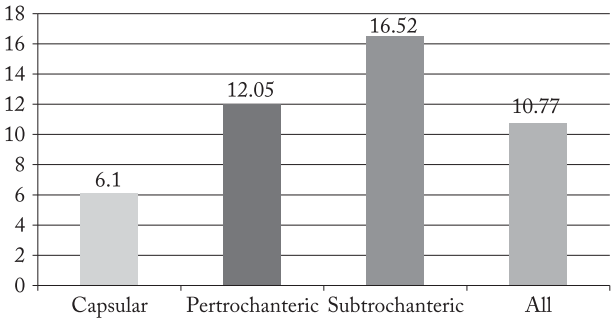

Fig. 1. Mean hemoglobin (Hb) drop (g/L) after admission in hip fracture patients.

Table 2. T-paired test for hemoglobin drop in hip fracture patients

Fracture type	t	p
Intracapsular	7.89	0.000
Pertrochanteric	15.74	0.000
Subtrochanteric	8.09	0.000
All	18.51	0.000

in the period between January 2011 and February 2015. There were 266 (71.1%) female and 108 (28.9%) male patients, mean age 76.48 (SD=9.50, range 35-102) years. There was no significant difference in age (F=2.11, p=0.123) and sex (F=0.01, p=0.994) among the three patient groups.

The initial on-admission and preoperative (after rehydration) Hb values are shown in Table 1. The mean Hb drop is shown in Figure 1. This Hb drop was statistically significant in all fracture types (Table 2).

Discussion

Hip fracture patients are commonly elderly people with comorbidities. The literature does not give much information on the preoperative change of blood count in these patients. The studies that evaluated intraoperative blood loss during hip surgery found a relatively small loss that could not explain the large difference between on-admission and postoperative Hb level[9,11].

The results of this study found a decrease in Hb level after admission and after rehydration. The mean expected Hb drop for capsular fractures should be 6.1 g/L, for pertrochanteric 12.05 g/L, and for subtrochanteric 16.52 g/L. This drop occurs after admission but prior to surgery. The difference of this drop among fracture types could be explained with greater bone surface area in subtrochanteric fracture and capsular tamponade in intracapsular fracture.

In their prospective study, Kumar *et al*. report a greater fall of Hb level in their 124 patients (2.23 g/dL Hb fall in subtrochanteric, 1.1 g/dL in intertrochanteric and 0.7 g/dL in intracapsular fractures)[7]. The mean decreases in Hb for the intracapsular and extracapsular fracture groups were 14.9 g/L and 20.2 g/L, respectively, as published in the retrospective study by Smith *et al*.[10].

Hip fractures are the leading cause of hospital admissions with a high length of stay in the elderly. They are associated with major impairments and disabilities, and result in high rates of institutionalization and mortality[13]. The average age of hip fracture patients has increased from 73 years in the 1960s to the current 79 years[3]. Factors associated with increased mortality include advanced age, male sex, poorly controlled systemic disease, psychiatric illness, low albumin (<3.0 g/dL), institutional residence, and operation before stabilization of the coexisting medical conditions[1].

Despite advances in surgical techniques and modern implants, hip surgery frequently requires transfusion (before, during or following surgery). High rates of blood typing and cross-matching, as well as unnecessary transfusions raise concern of inappropriate habits, adverse reactions and additional costs. Each unjustified transfusion is considered a human error[14]. In the USA, hip fracture surgery ranks second in the total number of blood units administered according to diagnostic groups[13]. Transfusion triggers vary between 70 and 100 g/L (most often they were 80 or 90 g/L)[15].

Most patients with hip fracture are elderly, and their functional reserve and the ability to compensate for physiologic stress are reduced. Since postoperative Hb less than 80 g/L has been associated with increased morbidity and the odds of death increases 2.5 times for each gram decrease in Hb below this level[15], Kumar *et al*. state that there is a strong argument for transfusing patients with Hb less than 100 g/L before or during surgery when postoperative Hb level below 80 g/L has to be avoided[7]. Adunsky *et al*. found that admission Hb levels lower than 120 g/L and pertrochanteric fractures were significantly more transfused, so they propose that cross-matching might be reserved only for patients presenting with Hb <120 g/L and/or pertrochanteric fractures, thus reducing the extent of unnecessary blood ordering[13].

The essence is prompt diagnosis and treatment of anemia in these patients to minimize the anemia related medical complications, functional recovery time, length of stay in hospital or rehabilitation units, and readmission rate. A restrictive transfusion policy should not be employed in these patients. A Hb concentration of 100 g/L should be accepted as a safe threshold for hip surgery. The Scottish guidelines network recommends these patients should have their Hb maintained above 90 g/L[7].

The level of the preoperative Hb drop should be taken into consideration when planning transfusion. If we use the results of this study, as well as the results of other studies that evaluated the average intraoperative blood loss[9,10], we could make some calculations of transfusion risks. According to the expected preoperative drop, expected intraoperative blood loss and the aim of maintaining Hb level around 100 g/L, cross-matching should be reserved for patients with on-admission Hb 120 g/L or less for pertrochanteric fractures planned for DHS surgery; for subtrochanteric fractures with 125 g/L or less; and for capsular fractures with 114 g/L or less planned for hemiarthroplasty (formula: on-admission Hb – average preoperative loss – average intraoperative loss for the planed intervention ≥100 g/L). Baseline blood samples are relatively inexpensive and easily interpreted. They are a modifiable factor that might improve the outcome.

Being retrospective, the design of this study should be considered as its limitation. Data on the time between injury and hospital admission were not available and not considered in result interpretation. We could not confirm whether or not it influenced the findings of this study.

In conclusion, the on-admission Hb level in hip fracture patients should be interpreted carefully, and the additional blood loss after rehydration prior to surgery should be considered. We advise collection of blood sample after rehydration, preoperatively. It would enable prompt diagnosis and treatment of anemia in these patients, proper transfusion planning, lower cost of cross-matching, and avoiding unnecessary blood transfusions.

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Sažetak

ANALIZA SNIŽENJA RAZINE HEMOGLOBINA NAKON PRIJMA U BOLESNIKA S PRIJELOMOM BEDRENE KOSTI

V. Kamiloski i *K. Kasapinova*

Studije koje su procjenjivale gubitak krvi tijekom operacije kuka utvrdile su relativno mali gubitak koji ne objašnjava veliko sniženje razine hemoglobina nakon operacije. Cilj ovog istraživanja bio je utvrditi pad razine hemoglobina nakon prijma i rehidracije u bolesnika s prijelomom bedrene kosti te identificirati bolesnike u kojih je potrebna transfuzija krvi. Ova retrospektivna studija obuhvatila je 374 bolesnika s prijelomom kuka kod kojih je operacija odgođena za više od 24 sata i s ponovljenom kompletnom krvnom slikom prije operacije nakon nadomještanja tekućine kroz najmanje 24 sata. Razina hemoglobina (g/L) analizirana je nakon prijma i nakon rehidracije. Rezultati su uspoređeni pomoću Studentova t-testa. Srednja vrijednost sniženja hemoglobina bila je 6,1 g/L kod kapsularnih, 12,05 g/L kod pertrohanternih prijeloma i 16,52 g/L kod subtrohanternih prijeloma. Takvo sniženje hemoglobina bilo je statistički značajno kod svih vrsta prijeloma. Značajno prijeoperacijsko sniženje hemoglobina treba uzeti u obzir kad se planira transfuzija krvi kod bolesnika s prijelomom bedrene kosti. Uzimanje uzoraka krvi prijeoperacijski nakon rehidracije omogućit će brzo dijagnosticiranje i liječenje anemije kod ovih bolesnika, ispravno planiranje transfuzije i križne probe.

Ključne riječi: *Krv, transfuzija; Hemoglobini; Kuk, frakture; Tekućine, terapija; Anemija*