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Utilization of Packed Cell and Whole Blood in Patients with Femur Fracture in a Tertiary Care Center: A Retrospective Study of 45 Cases

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Abstract

Background: Femur fractures are often associated with substantial blood loss, necessitating timely transfusion support. Optimizing the use of whole blood (WB) and packed red blood cells (PRBC) is essential for effective management in tertiary care settings.

Materials and Methods: This retrospective observational study was conducted at a tertiary care center and included 45 patients aged ≥18 years with radiologically confirmed femur fractures admitted between July 2022 and June 2023. Data were obtained from hospital records, and the blood bank registers. Data include demographics, blood group, and transfusion details.

Results: The study included 27 males (60.0%) and 18 females (40.0%), with a mean age of 46.1 ± 17.9 years. The most common blood groups were B+ (35.6%), O+ (31.1%), and A+ (24.4%). A total of 25 patients (55.6%) received WB and 27 (60.0%) received PRBC; of these, 20 (44.4%) received only PRBC, 18 (40.0%) only WB, and 7 (15.6%) both components. WB transfusions totaled 46 units (mean 1.67 ± 0.95/patient), while PRBC accounted for 50 units (mean 2.05 ± 1.12/patient). The highest WB utilization was in B+ patients (14 units), whereas O+ patients required the most PRBC (18 units). All patients (100%) required transfusion during hospitalization.

Conclusion: PRBC was the predominant transfusion modality in femur fracture patients, with higher utilization than WB. The predominance of B+ and O+ groups underscores the need for targeted inventory management. These findings support evidence-based transfusion protocols and optimized resource planning in orthopedic emergencies.

Keywords: Femur fracture, Blood transfusion, Packed red blood cells, Whole blood, Blood utilization

Introduction

In developing countries, femoral fractures represent a major public health challenge, accounting for significant morbidity and mortality in trauma care. They constitute a large proportion of orthopaedic emergencies, commonly resulting from road traffic accidents, falls, or high-energy trauma such as gunshot injuries [1, 2]. The incidence and prevalence of femoral fractures vary by region and are closely linked to local trauma epidemiology. In India, where road traffic injuries are among the leading causes of trauma admissions, femoral fractures contribute substantially to the orthopaedic workload in tertiary care centers [1, 2]

The etiology of femoral fractures demonstrates a bimodal distribution. Younger individuals usually sustain high-energy injuries, particularly from motor vehicle accidents, while older patients are more likely to sustain low-energy fractures due to osteoporosis or pathological conditions such as multiple myeloma [3, 4]. Femoral fractures can be simple, wedge, or complex, each requiring individualized management strategies [5]. Intramedullary nailing remains the preferred treatment modality in adults, with favorable outcomes when performed under optimal conditions. However, in resource-constrained

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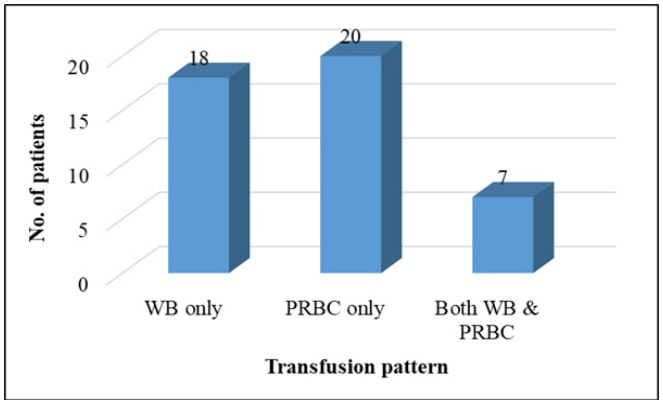

Figure 1: Transfusion pattern among femur fracture patients.

settings, lack of advanced equipment such as traction tables and fluoroscopy often necessitates alternative surgical approaches, increasing the risk of perioperative complications [6].

However, orthopaedic procedures, particularly for femoral fractures, are often associated with considerable blood loss, predisposing patients to anemia and necessitating transfusion support [7]. Intraoperative blood loss depends on surgical technique, patient factors, and operative duration, with estimates ranging between 800 and 1500 mL in major femoral surgeries [8]. Accurately quantifying blood loss remains difficult, with methods ranging from visual estimation and hematocrit changes to mathematical models such as Brecher's formula [9, 10]. Excessive blood loss may lead to hemorrhagic shock, requiring transfusion of blood products; however, unnecessary or liberal transfusion practices deplete scarce resources, increase healthcare costs, and may expose patients to adverse effects [11].

Blood transfusion in orthopedic trauma relies mainly on whole blood (WB) and packed red blood cells (PRBCs). While WB provides volume expansion, PRBC allows targeted correction of anemia and improves oxygen delivery with less risk of volume overload. Transfusion guidelines based on hemoglobin thresholds are still debated, and adherence to standardized practices is inconsistent [12, 13]. Optimizing transfusion practices is therefore crucial to ensure patient safety and rational resource utilization, particularly in tertiary care centers where demand frequently exceeds availability [14]. However, data on transfusion patterns, particularly the utilization of WB and PRBC in femur fracture patients in Indian tertiary care centers, remain limited. Therefore, present retrospective study was conducted to evaluate the utilization of WB and PRBC among patients admitted with femur fractures in a tertiary care setting.

Materials and Methods

This retrospective observational study was conducted at a tertiary care center to evaluate transfusion practices in femur fracture patients. Medical records of 45 patients admitted between July 2022 and June 2023 with radiologically confirmed femur fractures were reviewed. Patients aged ≥18 years who received at least one unit of blood component (WB or PRBCs) were included, while those with multitrauma requiring massive transfusion protocols or preexisting hematological disorders were excluded. Data were obtained from hospital records, ward registers, and the blood bank registers. Data includes demographics (age and gender), blood group (ABO and Rh), type and number of blood components transfused, and timing of transfusion in relation to surgery. For each patient, the total number of blood units was recorded to analyze utilization patterns across demographic subgroups and blood groups.

Statistical analysis

The collected data were compiled in Microsoft Excel and analyzed using descriptive statistics. Continuous variables were presented as mean ± standard deviation, categorical variables as counts and percentages. Utilization rates were calculated as the proportion of patients receiving each component. Mean units per patient were derived by dividing total units by the cohort size. Data were analyzed using the Statistical Package for the Social Sciences v25. $P < 0.05$ was considered significant.

Results

The study included a total of 45 patients with femur fractures, comprising 27 males (60.0%) and 18 females (40.0%), showing a male predominance. Most of the patients were in the 41–50-year age group (24.4%), followed by 31–40 years (20.0%) and 51–60 years (20.0%), with a mean age of 46.1 ± 17.9 years, (Table 1).

The most common blood group among the study population was B+, observed in 16 patients (35.55%), followed by O+ in 14 patients (31.11%) and A+ in 11 patients (24.44%). A smaller proportion of patients had AB+ blood group (4.44%). Rare blood groups such as B− and O− were identified in one patient each (2.22%, respectively), (Table 2).

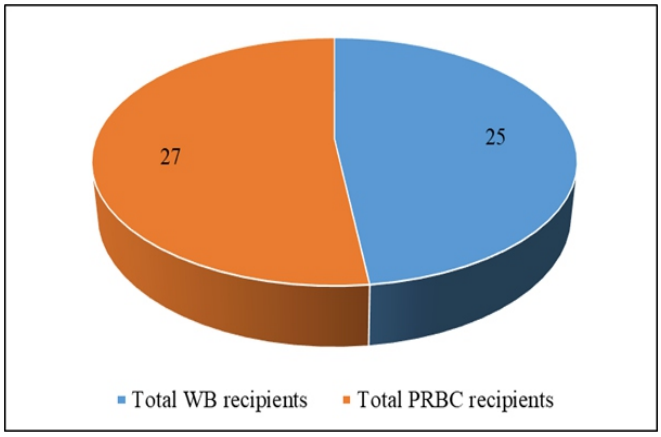

Figure 2: Utilization of blood products in femur fracture patients.

Table 1: Demographic profile of study participants ($n = 45$)

Demographic data	Number of patients (n)	Percentage
Age group (years)		
<30	7	15.6
31–40	9	20
41–50	11	24.4
51–60	9	20
>60	9	20
Gender		
Male	27	60
Female	18	40

Out of 45 patients, 20 patients (44.4%) received only PRBCs, making it the most commonly utilized blood component. 18 patients (40.0%) were transfused exclusively with WB, while 7 patients (15.5%) required a combination of both WB and PRBCs (Fig. 1).

A total of 25 patients (55.6%) received WB, which included 18 patients who received only WB and 7 patients who received both WB and PRBC. Similarly, 27 patients (60.0%) received PRBC, comprising 20 patients who received only PRBC and 7 patients who received both WB and PRBC (Fig. 2).

WB transfusions totaled 32 units, with the highest usage observed in patients with B+ blood group (14 units). PRBC transfusions totaled 40 units, with the highest usage among O+ patients (18 units). Smaller proportions of patients belonged to AB+ blood group (two patients) and rare blood groups B− and O− (one patient each), with correspondingly lower transfusion requirements. Overall, these findings indicate that both WB and PRBC were utilized across all blood groups, with PRBC slightly higher in total units transfused (Table 3).

Out of 45 patients, 20 (44.4%) received only PRBCs, while 18 (40.0%) received only WB. A smaller proportion, 7 patients (15.6%), required a combination of both WB and PRBC. In terms of total units transfused, WB-only patients received 30 units with a mean of 1.67 ± 0.95 units/patient, whereas PRBC-only patients received 41 units with a mean of 2.05 ± 1.12 units/patient. Patients who received both WB and PRBC were transfused a total of 16 units, with a mean of 2.29 ± 1.33 units/patient. Overall, 25 patients (55.6%) received WB (including WB-only and combined transfusions), accounting for 46 units with a mean of 1.84 ± 1.04 units/patient, while 27 patients (60.0%) received PRBC, accounting for 50 units with a mean of 1.85 ± 1.07 units/patient (Table 4).

Key clinical outcomes

1. Component therapy preference: PRBC transfusions were slightly more common, with 27 patients (60.0%) receiving PRBC compared to 25 patients (55.6%) receiving WB, indicating a preference for component-specific transfusion strategies in femur fracture management.
2. Transfusion efficiency: The mean units per patient were higher for PRBC (2.05 ± 1.12 units) than for WB (1.67 ± 0.95 units), reflecting targeted correction of anemia with PRBC.
3. Blood group implications: The majority of patients belonged to B+ (35.6%) and O+ (31.1%) blood groups, together accounting for 66.7% of cases, emphasizing the need to manage inventory.
4. Universal transfusion requirement: All patients (100%) required transfusion, highlighting the critical role of timely blood component availability in the management of femur fractures.

Discussion

Major orthopaedic procedures are often associated with considerable intraoperative blood loss, which varies between patients and institutions, thereby limiting the standardization of perioperative blood ordering protocols [15, 16]. Femoral fractures, in particular, are linked to substantial blood loss, frequently leading to anaemia and even haemorrhagic shock.

Table 2: Blood group-wise distribution of patients

Blood group	Number of patients (n)	Percentage
A+	11	24.44
B+	16	35.55
AB+	2	4.44
O+	14	31.11
B−	1	2.22
O−	1	2.22

Table 3: Blood group-wise distribution and utilization of blood products

Blood group	Patients (n)	Whole blood units	Packed red cell units
A+	11	6	11
AB+	2	1	1
B+	16	14	9
B−	1	1	1
O+	14	9	18
O−	1	1	0
Total	45	32	40

Table 4: Transfusion patterns and component utilization

Pattern	Patients, *n* (%)	Total units	Mean units per patient
WB only	18 (40.0)	30	1.67±0.95
PRBC only	20 (44.4)	41	2.05±1.12
Both WB and PRBC	7 (15.6)	16	2.29±1.33
WB recipients	25 (55.6)	46	1.82±1.04
PRBC recipients	27 (60.0)	50	1.85±1.07

WB: Whole blood, PRBC: Packed red blood cells

However, limited data exist regarding blood loss patterns across intraoperative and post-operative periods. Reported estimates vary widely, with studies indicating average intraoperative blood loss ranging from 800 mL to 1500 mL in different procedures [8]. Surgical blood loss often necessitates transfusion support. Blood transfusion in orthopaedic trauma plays a critical role in restoring circulating volume and maintaining oxygen delivery but must be used judiciously according to individual patient needs [11].

Patient-related factors such as age and gender significantly influence transfusion needs. Men are reported to experience higher intraoperative blood loss, whereas females often require more transfusions due to lower baseline haemoglobin levels [17]. Elderly patients tend to have additional comorbidities, which predispose them to higher transfusion requirements and poorer outcomes [18]. In the present study, 45 patients with femur fractures were evaluated, comprising 27 males (60.0%) and 18 females (40.0%), reflecting a male predominance. The mean age was 46.1 ± 17.9 years, with most patients belonging to the 41–50-year age group (24.4%), followed by 31–40 years (20.0%) and 51–60 years (20.0%). These findings are consistent with previous studies [17, 18, 19, 20, 21] which report that middle-aged and older individuals, particularly males, are more commonly affected due to both high-energy trauma and age-related bone fragility.

In the present study, all patients required blood transfusions, emphasizing the critical role of blood bank preparedness in orthopedic trauma care. A total of 25 patients (55.6%) received WB, while 27 patients (60.0%) received PRBC. The preference for PRBC over WB in this study aligns with global trends favoring component therapy, which allows targeted correction of anemia and reduces the risks of volume overload and transfusion-related complications (Yaddanapudi and Yaddanapudi [11]; Carson et al. [12]).

In terms of transfusion efficiency, the mean number of units transfused per patient was higher for PRBC (2.05 ± 1.12) compared to WB (1.67 ± 0.95). These findings are comparable to those reported by Soleimani et al. [8], who observed that orthopaedic trauma patients frequently require multiple units of PRBC due to significant perioperative blood loss. Moreover, our results are in line with international guidelines recommending restrictive transfusion thresholds, which often limit transfusion to 1–2 units/patient depending on haemoglobin levels and clinical status (Carson et al. [12]).

However, PRBC transfusions slightly exceeded WB both in terms of the number of patients transfused (60.0% vs. 55.6%) and total units administered (50 vs. 46). The mean units per patient were comparable between WB (1.82 ± 1.04) and PRBC (1.85 ± 1.07), though patients requiring both components had a higher mean utilization (2.29 ± 1.33 units). These findings are consistent with global trends favouring component therapy over WB transfusion. Previous studies conducted by Jang et al. [22] and Xie et al. [23] in orthopaedic trauma have highlighted PRBC as the mainstay for correcting acute blood loss, due to better efficacy in improving oxygen-carrying capacity while minimizing risks of volume overload and alloimmunization. In a study by Gupta et al., [19] PRBC accounted for nearly two-thirds of transfusions in long bone fractures, closely mirroring the 60.0% utilization observed in our series.

Blood group distribution in current study revealed a predominance of B+ (35.6%) and O+ (31.1%), which together accounted for two-thirds of the cases. This pattern is consistent with Indian population studies done by Giri et al. [24] and Jaff et al. [25], where B+ and O+ are among the most common blood groups. Transfusion utilization also reflected this distribution, with B+ patients receiving the highest WB use (14 units) and O+ patients the highest PRBC use (18 units). This highlights the importance of prioritizing B+ and O+ blood stocks for trauma and emergency surgery in Indian tertiary centers.

Overall, the transfusion patterns observed in present study underscore the shift toward PRBC use in line with evidence-based transfusion practices, while also reinforcing the need for institution-specific protocols that consider demographic trends, surgical needs, and blood bank resource planning.

This study is limited by its retrospective design, small sample size, and single-center setting, which may affect the generalizability of the findings. Data were dependent on hospital and blood bank records, and the study did not assess clinical correlations such as fracture type, surgical technique, or patient comorbidities. In addition, long-term outcomes, transfusion reactions, and other blood components such as platelets or plasma were not evaluated. Future prospective multicenter studies incorporating haemoglobin thresholds, intraoperative blood loss measurements, and clinical outcomes such as transfusion reactions and length of hospital stay would

provide stronger evidence and more comprehensive guidance for transfusion practices in femur fracture patients.

Conclusion

The present study demonstrates that patients with femur fractures have substantial transfusion requirements, with PRBCs being the predominant component used over WB, reflecting a shift toward component-focused transfusion strategies. PRBC showed higher utilization rates and mean units per patient compared to WB. The predominance of B+ and O+ blood groups highlights the need for targeted blood bank inventory management to meet perioperative demands. Demographic patterns, including male predominance and middle-aged involvement, align with previous reports and reflect the dual impact of high-energy trauma and age-related bone fragility. These findings highlight the importance of evidence-based transfusion protocols and efficient resource planning in orthopaedic emergencies, particularly in tertiary care settings.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Conflict of Interest: NIL; **Source of Support:** NIL

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