

# Intraoperative Goal-Directed Therapies in Femoral and Pelvic Osteotomies in Children and In-Hospital Postoperative Outcomes

Claudine Kumba<sup>1</sup> , Mathilde Gaume<sup>2</sup>, Arayik Barbarian<sup>1</sup>, Zaga Péjin<sup>2</sup>

<sup>1</sup>Department of Pediatric Anesthesia and Critical Care, Hôpital Universitaire Necker Enfants Malades, Assistance Publique Hôpitaux de Paris, APHP, Université de Paris, Paris, France

<sup>2</sup>Department of Pediatric Orthopedic Surgery, Hôpital Universitaire Necker Enfants Malades, Assistance Publique, Hôpitaux de Paris, APHP, Université de Paris, Paris, France

Email: [claudine.kumba@aphp.fr](mailto:claudine.kumba@aphp.fr), [mathilde.gaume@aphp.fr](mailto:mathilde.gaume@aphp.fr), [arayik.barbarian@aphp.fr](mailto:arayik.barbarian@aphp.fr), [zagorka.pejin@aphp.fr](mailto:zagorka.pejin@aphp.fr)

**How to cite this paper:** Kumba, C., Gaume, M., Barbarian, A. and Péjin, Z. (2021) Intraoperative Goal-Directed Therapies in Femoral and Pelvic Osteotomies in Children and In-Hospital Postoperative Outcomes. *Open Journal of Orthopedics*, 11, 327-334.

<https://doi.org/10.4236/ojo.2021.1111031>

**Received:** October 8, 2021

**Accepted:** November 15, 2021

**Published:** November 18, 2021

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## Abstract

**Background:** Femoral and pelvic osteotomies are potential hemorrhagic interventions where transfusion requirements can be necessary. **Objective:** We undertook a secondary analysis of patients who underwent femoral and pelvic osteotomy in the initial cohort. The objective of this secondary analysis was to describe intraoperative and postoperative outcomes and to describe intraoperative management in these patients in terms of blood product management and fluid and hemodynamic therapy with the aim of implementing optimization management protocols for postoperative outcome improvement. **Methods:** A secondary analysis of patients who underwent femoral and pelvic osteotomy surgery was included in the initial retrospective study. **Results:** There were eighteen patients with a mean age of  $104 \pm 47.1$  months. Four (22.2%) patients had intraoperative and/or postoperative complications. One patient (5.6%) had an intraoperative hemorrhagic shock, two patients (11.1%) had postoperative neurologic failure, and one patient (5.6%) had postoperative wound sepsis. The transfusion rate was 50% in nine patients. **Conclusion:** Femoral and pelvic osteotomies are interventions where blood, transfusion and fluid requirements can be increased; thus, this implies the necessity of a global patient blood management protocol with point-of-care tests and fluid- and hemodynamic-guided protocols with validated tools in children for intraoperative and postoperative outcome optimization.

## Keywords

Femoral Osteotomy, Pelvic Osteotomy, Patient Blood Management, Fluid and Hemodynamic Goal-Directed Therapy, Children, Postoperative Outcome

## 1. Introduction

Femoral and pelvic osteotomies are common interventions in children with cerebral palsy [1] [2]. This functional surgery aims to improve the quality of life in fragile patients in terms of pain and postural discomfort that can be observed in hip displacement and can impact the daily quality of life in terms of positioning and nursing [3] [4]. Femoral and pelvic osteotomies are also performed in patients who have sequelae of developmental dysplasia of the hip, sequelae of septic arthritis of the hip, Legg-Calvé-Perthes disease, skeletal dysplasia, etc. [5] [6] [7].

Femoral and pelvic osteotomies are potential hemorrhagic interventions where transfusion requirements can be necessary due to the surgical characteristics of the interventions. A retrospective observational study was undertaken to determine predictors of adverse intraoperative and postoperative outcomes in patients undergoing neurosurgery and abdominal and orthopedic surgery at our hospital Necker Enfants Malades University Hospital [8]. Age, American Society of Anesthesiologists Score (ASA), emergency situations, surgery and transfusion were independent predictors of intraoperative and postoperative outcomes in terms of morbidity, reoperations, length of stay in the intensive care unit (LOSICU), length of stay in hospital in the conventional hospitalization ward (LOS), total length of stay in hospital (LOSICU + LOS) and length of mechanical ventilation (LMV) [8] [9]. We undertook a secondary analysis of patients who underwent femoral and pelvic osteotomy in the initial cohort. Similar secondary analyses have been undertaken in other surgical interventions [10] [11] [12]. The objective of this secondary analysis was to describe intraoperative and postoperative outcomes and to describe intraoperative management in these patients in terms of blood product management and fluid and hemodynamic therapy with the aim of implementing optimization management protocols for postoperative outcome improvement.

## 2. Methods and Materials

**Methods:** Secondary analysis of patients who underwent femoral and pelvic osteotomy surgery was included in the initial retrospective study [8].

The study was approved by the Ethics Committee of Necker Enfants Malades University Hospital under registration number 2017-CK-5-R1 on 21 March 2017.

**Inclusion:** Patients were retrospectively included from 1 January 2014 to 17 May 2017.

Since we aimed to include pediatric patients, the inclusion criteria were patients aged less than 18 years who underwent femoral and pelvic osteotomy included in the initial retrospective study.

The exclusion criteria were patients aged more than 18 years old and patients who did not undergo femoral or pelvic osteotomy included in the initial study.

**Intraoperative and postoperative patient management:** In our hospital, patients who underwent femoral and pelvic osteotomy were managed intraopera-

tively according to a defined protocol as described hereafter.

Preoperatively, patients had iron supplementation at 5 - 10 mg/kg/day, and a complete blood cell count and blood group were available.

Induction of anesthesia was inhalational with sevoflurane in an oxygen-air mixture and sufentanil as an IV bolus of 0.2 µg/kg. Two large-bore peripheral intravenous (IV) lines were inserted. Airway was secured with oro-tracheal intubation. All patients had nasogastric tubing, an indwelling bladder catheter inserted, a central core temperature probe, a Bair Hugger® and an IV fluid warming device.

Maintenance of anesthesia was performed with sevoflurane. An epidural lumbar catheter for intraoperative and postoperative analgesia was inserted after the induction of anesthesia. Intraoperative epidural analgesia was performed with levobupivacaine 0.0625% as an infusion rate of 0.2 - 0.3 mL/kg/h.

Antibiotic prophylaxis was performed with a 50 mg/kg IV bolus of cefazolin. Tranexamic acid was administered as a 30 mg/kg IV bolus over 30 minutes followed by an intravenous infusion of 10 mg/kg/h.

Fluid therapy was performed with crystalloids as a 10 - 20 mL/kg bolus (Ringer Lactate® or chloride sodium 0.9%) or colloids as a 30 mL/kg bolus (plasmion® or voluven®). Intraoperative hemoglobin levels were monitored on a regular basis.

Postoperative analgesia was performed with epidural analgesia with levobupivacaine 0.0625% at an infusion rate of 0.1 - 0.2 mL/kg/h, IV acetaminophen at 15 mg/kg/6h, IV ketoprofen at 1 mg/kg/12h or oral ibuprofen at 10 mg/kg/8h and IV clonidine at 1 - 2 µg/kg. A rescue postoperative analgesia protocol was performed with IV nalbuphine at 0.2 mg/kg/6h or with oral morphine at 1 mg/kg/day divided 4 - 6 times.

Postoperative spasticity prevention and treatment were realized with oral or intrarectal diazepam at 50 µg/kg/4h.

Depending on general status and comorbidity, patients were transferred postoperatively in the pediatric intensive care unit (PICU) for surveillance or in the postinterventional care unit (PACU) and afterward in the conventional surgical hospitalization ward.

Intravenous iron supplementation at postoperative day 1 was performed depending on postoperative hemoglobin levels.

Statistics: Statistics were analyzed with XLSTAT 2020.4.1. software. Continuous variables were expressed as medians with ranges or means with standard deviations. Category variables were described in proportions.

### 3. Results

**Table 1** illustrates the general characteristics.

There were eighteen patients with a mean age of  $104 \pm 47.1$  months and a median weight of 22 [16 - 55] kilograms. Eleven (61.1%), four (22.2%), and three (16.7%) patients had ASA scores of II, III and IV, respectively. Eleven (61.1%) and seventeen (38.9%) patients underwent femoral and pelvic osteotomy, respectively. There were seventeen (94.4%) elective interventions and one (5.6%) urgent surgery.

**Table 1.** General characteristics.

Characteristic	N = 18
Mean age $\pm$ standard deviation in months	104 $\pm$ 47.1
Median weight [interquartile range] in kilograms	22 [16 - 55]
ASA II n (%)	11 (61.1)
ASA III n (%)	4 (22.2)
ASA IV n (%)	3 (16.7)
Femoral osteotomy n (%)	11 (61.1)
Pelvic osteotomy n (%)	7 (38.9)
Emergency surgery n (%)	1 (5.6)
Elective surgery n (%)	17 (94.4)
Re-operation n (%)	0 (0)
Patients with intra-operative and or postoperative complications (organ failure or sepsis) n (%)	4 (22.2)
Intra-operative hemorrhagic shock n (%)	1 (5.6)
Postoperative neurologic failure n (%)	2 (11.1)
Postoperative surgical wound sepsis n (%)	1 (5.6)
In-hospital mortality n (%)	0 (0)
Transfusion n (%)	9 (50)
Median length of intensive care unit stay in days [range]	0 [0 - 12]
Median length of hospital stay in days [range]	6 [1 - 23]
Median total length of hospital stay in days [range]	6 [2 - 32]
Median length of mechanical ventilation in days [range]	0 [0 - 2]
Median packed red blood cell volume in units [range]	0 [0 - 2]
Median fresh frozen plasma volume in units [range]	0 [0 - 0]
Median concentrated platelet units [range]	0 [0 - 0]
Mean preoperative hemoglobin levels $\pm$ standard deviation in g/dL	10.36 $\pm$ 1.7
Mean postoperative hemoglobin levels $\pm$ standard deviation in g/dL	10.3 $\pm$ 1.0
Median crystalloid volume in mL [range]	1150 [750 - 2000]
Median colloid volume in mL [range]	400 [0 - 900]

Four (22.2%) patients had intraoperative and/or postoperative complications. One patient (5.6%) had intraoperative hemorrhagic shock, two patients (11.1%) had postoperative neurologic failure, and one patient (5.6%) had postoperative wound sepsis. There were no reoperations and no in-hospital mortality. Nine patients (50%) had intraoperative transfusion with packed red blood cell units (PRBCs). The median length of intensive care unit stay (LOSICU) was 0 [0 - 12]

days. The median length of hospital stay (LOS) in the conventional surgical ward was 6 [1 - 23] days. The median total length of hospital stay (TLOS = LOSICU + LOS) was 6 [2 - 32] days. The median length of mechanical ventilation was 0 [0 - 2] days. The median packed red blood cell volume was 0 [0 - 2] units. No fresh frozen plasma or platelets were administered. The mean preoperative hemoglobin level was  $10.36 \pm 1.7$  g/dL. The mean postoperative hemoglobin level was  $10.3 \pm 1.0$  g/dL. The median crystalloid volume was 1150 [750 - 2000] mL, and the median colloid volume was 400 [0 - 900] mL.

**Table 2** illustrates co-morbidities.

The most common comorbidities were sequelae of hip arthritis, developmental dysplasia of the hip, and Legg-Calvé-Perthes disease in nine patients (50%), followed by cerebral palsy in 3 patients (16.7%), among which two (11.1%) had cerebral anoxic lesions and one (5.6%) had psychomotor deficiency. Two patients (11.1%) had Ewing's sarcoma and Gorlin's syndrome. One patient (5.6%) had osteogenesis imperfecta.

#### 4. Discussion

In this secondary analysis, the proportion of patients with complications and transfusion was 22% and 50% respectively. Femoral and pelvic osteotomies are interventions performed in patients who can have a fragile general status, as illustrated by the comorbidities in our cohort. In these surgical settings, blood loss and fluid requirements can be high, as illustrated by the transfusion rate and the amount of fluid administered intraoperatively. This implies the inclusion of transfusion protocols guided with point-of-care tests and fluid and hemodynamic therapy protocols for optimal intraoperative patient blood management and fluid therapy in this surgical setting.

As described in previous studies, these goal-directed therapies have the objectives of improving postoperative outcomes [10]-[19]. Transfusion and intraoperative nonoptimal hemodynamic parameters have been associated with adverse postoperative outcomes in surgical patients [8] [9] [19]. Non-optimal preoperative, intraoperative and postoperative hemoglobin levels have been

**Table 2.** Co-morbidities.

Co-morbidity	Number of patients (%)
Sequelae of hip arthritis, developmental dysplasia of the hip, Legg-Calvé-Perthes disease	9 (50)
Cerebral anoxic lesions	2 (11.1)
Ewing's sarcoma	2 (11.1)
Gorlin's syndrome	2 (11.1)
Osteogenesis imperfecta	1 (5.6)
Psychomotor deficiency	1 (5.6)

correlated with adverse postoperative outcomes in surgical patients [20]. Optimal hemoglobin levels depend on patient status, comorbidities and surgical context. Optimal hemoglobin levels are those that do not favor the development of a dependent relationship between oxygen consumption and oxygen delivery [16] [17]. Anemia has been reported to be correlated with in-hospital adverse outcomes [21] [22]. Benefits and risks related to transfusion and anemia need to be balanced when making a decision for blood transfusion.

Fluid therapy with aortic blood flow peak velocity variation with transthoracic echocardiography or esophageal Doppler probe is a validated tool in children to assess fluid responsiveness in patients under anesthesia [18] [23].

This secondary analysis of patients who underwent femoral and pelvic osteotomies was an occasion to introduce and encourage the integration of goal-directed therapies in intraoperative patient management to improve and upgrade postoperative evolution in these fragile patients.

## 5. Conclusion

Femoral and pelvic osteotomies are interventions where blood, transfusion and fluid requirements can be increased; thus, this implies the necessity of global patient blood management protocols with point-of-care tests and fluid- and hemodynamic-guided protocols with validated tools in children for intraoperative and postoperative outcome optimization.

## Conflicts of Interest

The authors declared no conflicts of interest.

## Authors Contributions

Claudine Kumba conceptualized and designed the study and drafted the initial manuscript. She designed the data collection instruments, collected data, carried out initial and final analyses.

Zaga Péjin reviewed the manuscript.

Mathilde Gaume reviewed the manuscript.

Arayik Barbarian reviewed the manuscript.

## Presentation of Preliminary Results

This manuscript was registered as a preprint under the DOI registration number <https://doi.org/10.21203/rs.3.rs-777279/v2> on Research Square a preprint platform.

## Ethics Approval

This study received approval from the Ethics Committee of Necker on 21 March 2017 under registration number 2017-CK-5-R1 and waived patient consent.

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