

Scoliosis in Children: Impact of Goal Directed Therapies on Intra-operative and Postoperative Outcomes

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Short Report

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Abstract

Background: Scoliosis is among interventions with high postoperative complication rates due to the characteristics of the surgery, where blood loss, transfusion and fluid requirements can be increased.

A monocentric retrospective observational study was undertaken earlier to determine predictors of intraoperative and postoperative outcomes in surgical patients. In this initial cohort, there were patients who underwent scoliosis surgery, and a secondary analysis to describe outcomes in these patients was realized and is presented here.

Objective: To describe intraoperative and postoperative outcomes in patients under 18 years old in scoliosis surgery included in the initial study and to propose improvement implementation measures.

Methods: Secondary analysis of patients undergoing scoliosis surgery. The study was approved by the Ethics Committee.

Results: There were 116 patients with a mean age of 147.5 ± 40.2 months. Twenty-eight patients (24.1%) presented intraoperative and/or postoperative complications. The most common intraoperative complication was hemorrhagic shock in 3 patients (2.6%). The most common postoperative organ failure was neurologic in seven patients (6%), respiratory in 3 patients (2.6%), cardio-circulatory in 2 patients (1.7%) and renal failure in one patient (0.9%).

The most common postoperative infection was surgical wound sepsis in 8 patients (6.9%), urinary sepsis in three patients (2.6%), and abdominal sepsis and septicemia in two patients (1.7%).

twelve patients (10.3%) had reoperations.

Fifty-six patients (48.3%) had intraoperative transfusion.

There was no in-hospital mortality.

Conclusion: Integrating goal-directed therapies in this surgical setting could improve postoperative outcomes.

Introduction

Scoliosis surgery is one of the most common performed major elective surgeries in our Hospital.

This disorder of the vertebral column is classified as idiopathic or juvenile and neuromuscular.

The etiopathology of juvenile scoliosis is unknown whereas neuromuscular scoliosis can be associated with neuromuscular diseases, bone diseases or other syndromes. Postoperative morbidity in scoliosis is high due to the characteristics of the surgery where blood losses, transfusion and fluid therapy requirements can be increased (1). The patient global status is one of the predictors of postoperative

evolution (2). There is growing evidence that applying enhanced recovery after surgery protocols in scoliosis surgery in children reduces postoperative morbidity in terms of organ dysfunction and length of hospital stay (LOS) (3). We conducted earlier in our Hospital a monocentric observational study in neurosurgical, abdominal surgical and orthopedic patients to determine predictors of intra-operative and postoperative outcomes (2). In this cohort of 594 patients there were patients who underwent scoliosis surgery. We aimed with this secondary analysis of the initial study to describe intraoperative and postoperative outcomes in patients who had scoliosis surgery and to implement improved intraoperative patient management protocols with the objectives of optimizing postoperative outcome in this surgical population.

Methods And Materials

Secondary analysis of patients who underwent scoliosis surgery included in the initial study (2).

The study was registered to the National Commission for Computer Science and Liberties (CNIL) under the number 2028257 v0 on 21 February 2017 and approved by the Ethics Committee of Necker under the registration number 2017-CK-5-R1 on 21 March 2017.

Inclusion criteria were patients included in the initial study aged less than 18 years old and who underwent scoliosis surgery.

Exclusion criteria were patients above 18 years old and who did not undergo scoliosis surgery included in the initial study.

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

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

In our Hospital, scoliosis surgical patients are managed perioperatively according to a protocol described here. Preoperatively patients have respiratory functional tests, iron and erythropoietin supplementation, complete dental examination, nasal antibiotic therapy with mupirocin and a special fiber free diet several days prior to surgery, complete blood cell count and packed red blood cells units available.

Intraoperatively 2 large peripheral intravenous lines and an arterial catheter are inserted; patients are monitored with bispectral index, indwelling bladder catheter, nasogastric tubing, central core temperature probe, fluid warming system, warming blanket and somesthesia evoked potentials. Induction of anesthesia can be inhalational with sevoflurane or intravenous with propofol, remifentanil and ketamine. Maintenance of anesthesia is intravenous with propofol, remifentanil and ketamine. Airway is secured with orotracheal or nasotracheal intubation. Tranexamic acid is administered as an intravenous bolus of 30 mg/kg followed by an intravenous infusion of 10 mg/kg/h. A cell saver is available in case of neuromuscular scoliosis. Antibiotic prophylaxis is performed with cefazolin and or vancomycin

depending on patient's microbiological status. Fluid therapy is performed with crystalloids as 10–20 ml/kg bolus and colloids (plasmion®) as 30 ml/kg bolus.

The objective is to maintain mean arterial pressure above 60 mmHg.

Postoperative analgesia is realized with spinal analgesia with morphine as 5µg/kg (maximum 500 µg) administered intraoperatively, acetaminophen, ketoprofen, clonidine and patient controlled analgesia with intravenous bolus morphine.

Patients are extubated in the operation room or in the recovery room.

Results

Table 1 illustrates the general characteristics

Table 1
General characteristics

Characteristic	N = 116
Mean age ± standard deviation in months	147.5 ± 40.2
Median weight [interquartile range] in kilograms	34[24-45]
ASA I n (%)	1(0.9)
ASA II n (%)	35 (30)
ASA III n (%)	63 (54.3)
ASA IV n (%)	17 (14.7)
Idiopathic scoliosis n (%)	45 (38.8)
Neuromuscular scoliosis n (%)	71 (61.2)
Emergency surgery n (%)	5 (4.3)
Elective surgery n (%)	111 (95.7)
Re-operation n (%)	12 (10.3)
Patients with intra-operative and or postoperative complications (organ failure or sepsis) n (%)	28 (24.1)
Intra-operative anaphylaxis n (%)	1 (0.9)
Intra-operative respiratory failure n (%)	1 (0.9)
Intra-operative hemorrhagic shock n (%)	3 (2.6)
Postoperative renal failure n (%)	1 (0.9)
Postoperative cardio-circulatory failure n (%)	2 (1.7)
Postoperative respiratory failure n (%)	3 (2.6)
Postoperative neurologic failure n (%)	7 (6)
Postoperative abdominal sepsis n (%)	2(1.7)
Postoperative septicemia n (%)	2 (1.7)
Postoperative urinary sepsis n (%)	3 (2.6)
Postoperative surgical wound sepsis n (%)	8 (6.9)
In-hospital mortality n (%)	0 (0)
Transfusion n (%)	56 (48.3)
Median length of intensive care unit stay in days [range]	4[0 – 25]

Characteristic	N = 116
Median length of hospital stay in days [range]	10[1 - 50]
Median total length of hospital stay in days [range]	12[2 - 67]
Median length of mechanical ventilation in days [range]	0[0-21]
Median packed red blood cells volume in units [range]	0[0-3]
Median fresh frozen plasma volume in units [range]	0[0-5]
Median concentrated platelet units [range]	0[0-2]
Mean preoperative hemoglobin levels \pm standard deviation in g/dL	12.4 \pm 1.7
Mean postoperative hemoglobin levels \pm standard deviation in g/dL	10.7 \pm 1.6
Median crystalloid volume in ml [range]	1750[500-4684]
Median colloid volume in ml [range]	2000[0 - 6952]

There were 116 patients with a mean age of 147.5 ± 40.2 months and median weight of 34 kilograms [24–45]. 63 patients (54.3%) were American Society of Anesthesiologists grade 3 (ASA 3), 17 patients (14.7%) were ASA 4. Seventy-one patients (61.2%) had neuromuscular scoliosis and forty-five patients (38.8%) had idiopathic scoliosis. 111 patients (95.7%) had elective surgery.

Twenty-eight patients (24.1%) presented intraoperative and or postoperative complications.

The most common intraoperative complication was hemorrhagic shock in 3 patients (2.6%) followed by anaphylaxis and respiratory failure in one patient (0.9%) respectively. The most common postoperative organ failure was neurologic in seven patients (6%) followed by respiratory in 3 patients (2.6%), followed by cardio-circulatory in 2 patients (1.7%) and renal failure in one patient (0.9%).

The most common postoperative infection was surgical wound sepsis in eight patients (6.9%), followed by urinary sepsis in three patients (2.6%), followed by abdominal sepsis and septicemia in two patients (1.7%) respectively.

Twelve patients (10.3%) had reoperations.

Fifty-six patients (48.3%) were intraoperatively transfused with packed red blood cells and or fresh frozen plasma and or platelet units.

There was no in-hospital mortality.

Median length of intensive care unit stay was 4[0 - 25] days. Median length of hospital stay was 10[1 - 50] days. Median total length of hospital stay was 12[2 - 67] days. Median length of mechanical

ventilation was 0[0–21] days.

Table 2 illustrates co-morbidities.

Table 2
Co-morbidities

Co-morbidity	Number of patients (%)
Central Core Myopathy	1 (0.9)
Cerebral anoxic lesions	22 (18.9)
Congenital heart disease	3 (2.6)
Convulsive encephalopathy	2 (1.7)
Di George Syndrome	2 (1.7)
Ewing's sarcoma	1 (0.9)
Goldenhar's syndrome	1 (0.9)
Gorlin's syndrome	2 (1.7)
Hurler's syndrome	2 (1.7)
Muscular dystrophy	2 (1.7)
Myelomeningocele	4 (3.5)
Neurofibromatosis	7 (6.0)
Osteogenesis imperfecta	4 (3.5)
Pierre Robin syndrome	2 (1.7)
Polymalformative syndrome	4 (3.5)
Polytrauma	2 (1.7)
Prader Willi syndrome	2 (1.7)
Psychomotor deficiency	3 (2.5)
Scoliosis	1 (0.9)
Sepsis	1 (0.9)
Spina Bifida	2 (1.7)
Spinal muscular amyotrophy	2 (1.7)
West syndrome	1 (0.9)
Williams syndrome	1 (0.9)
Xeroderma pigmentosum	1 (0.9)

The most common co-morbidities were cerebral anoxic lesions in 22 patients (18.9%), followed by neurofibromatosis in 7 patients (6%), followed by myelomeningocele, osteogenesis imperfecta and polymalformative syndrome in 4 patients (3.5%) respectively, followed by congenital heart disease and psychomotor deficiency in 2 patients (2.5%) respectively.

Discussion

With regards to the rate of patients with intraoperative and or postoperative complications, including transfusion guided protocols with point of care tests, goal directed fluid and hemodynamic therapy with validated tools and parameters in children and integrating enhanced recovery after surgery protocols to optimize intraoperative management in scoliosis surgery could improve postoperative outcome in this surgical setting (3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15).

To improve blood product administration practices in scoliosis surgery, transfusion guided protocols with point of care viscoelastic assays have to be included in this setting. Point of care tests in hemorrhagic interventions have been shown to reduce fresh frozen plasma administration and length of hospital stay in children (4). Algorithms with rotational thromboelastometry are illustrated in Figs. 1 to 3 to guide transfusion in hemorrhagic surgery (15). Intraoperative goal directed fluid and hemodynamic therapy protocols with validated tools and parameters in children need to be included in intraoperative management in this surgical intervention to guide fluid and vasoactive therapy. Monitoring mean blood pressure is not enough for optimal hemodynamic management. Fluid management is best assessed with aortic blood flow peak velocity variation with echocardiography or esophageal doppler probe (13). The limiting factor of echocardiography is expertise. Transthoracic echocardiography can be difficult to perform if the patient is in prone position which can limit access to the apex or the sternal notch and the solution can be either an esophageal doppler probe or transoesophageal echocardiography however the latter necessitates expertise. Flotrac/Vigileo has been shown to reduce blood product administration, fluid requirements, postoperative pulmonary and gastrointestinal complications and length of intensive care unit stay in spine surgery (11). Stroke volume variation with Flotrac/Vigileo can be used for fluid therapy. With this device, stroke volume variation is determined with the arterial pressure waveform analysis however evidence in children with Flotrac/Vigileo on the impact of postoperative outcome are lacking (10, 12). Studies in children with Flotrac/Vigileo are needed to clarify the impact on postoperative outcome.

Enhanced recovery after surgery protocols have been shown to decrease postoperative complications in scoliosis surgery in children, integrating these pathways in this surgical setting can improve postoperative evolution (3). Predictors of postoperative outcomes include patient's global status, type of surgery, emergency age and transfusion (14). Goal directed therapies are possible solutions for postoperative outcome improvement in critical ill children and in major pediatric surgery.

Conclusion

To upgrade postoperative outcome in pediatric scoliosis surgery, transfusion guided protocols with point of care tests, goal directed fluid and hemodynamic therapy with validated tools and parameters in children and enhanced recovery after surgery need to be included in this surgical setting management.

Declarations

Conflict of Interest: The author declared no conflicts of interest.

Funding: None

Authors contribution:

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.

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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Figures

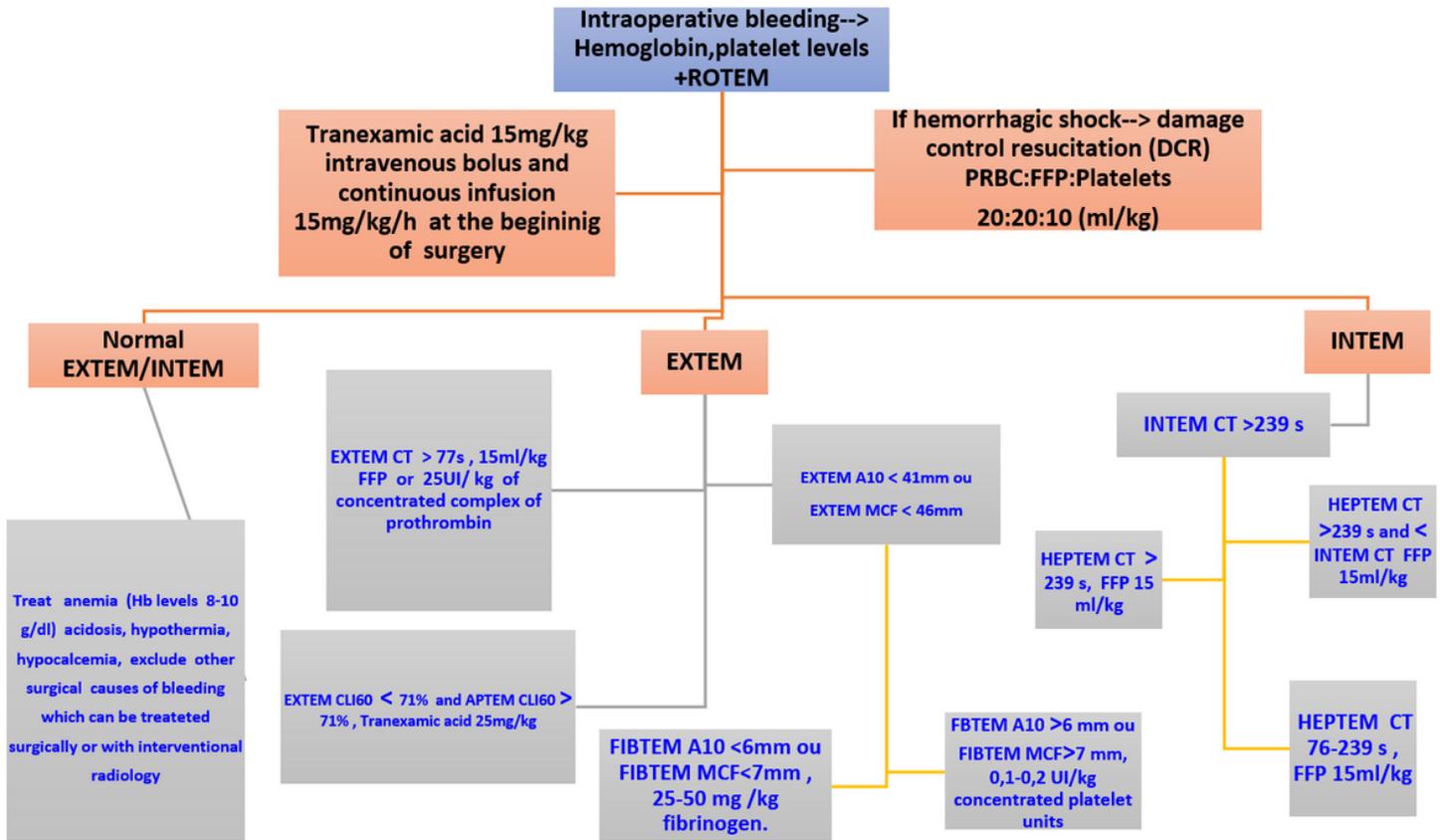


Figure 1

ROTEM Algorithm in children between enfant 0-24 months. CT=coagulation time in seconds, A10= clot firmness at 10 minutes, MCF =maximum clot firmness, CLI60= lysis index in % 60 minutes after CT, ML= maximum lysis in %, FFP=fresh frozen plasma, PRBC=packed red blood cells, Hb=hemoglobin

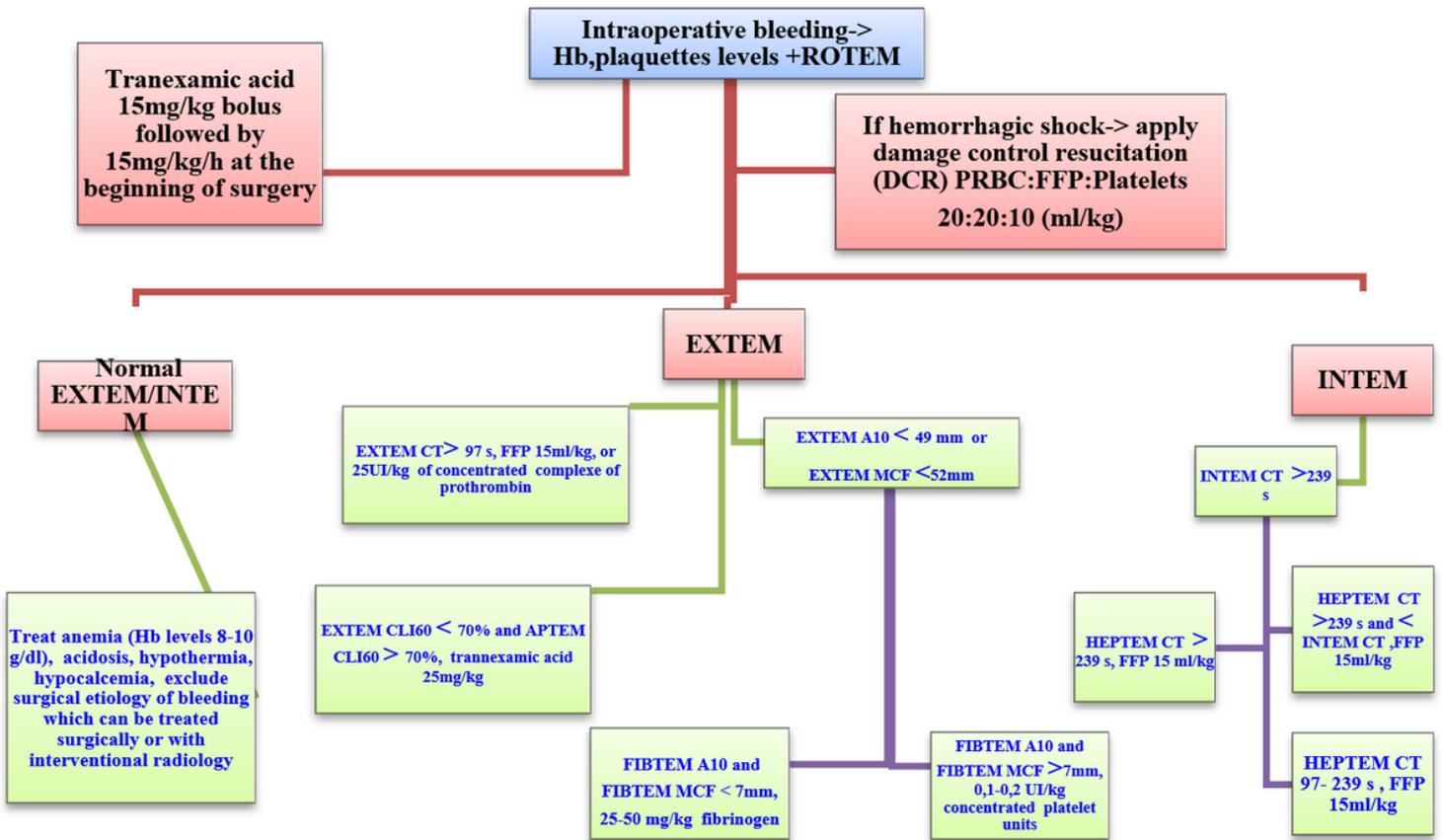


Figure 2

ROTEM Algorithm in children 2-16 years. CT=coagulation time in seconds, A10= clot firmness after 10 minutes, MCF =maximum clot firmness, CLI60= lysis index in % 60 minutes after CT, ML= maximum lysis in %, FFP=fresh frozen plasma, PRBC=packed red blood cells, Hb=hemoglobin

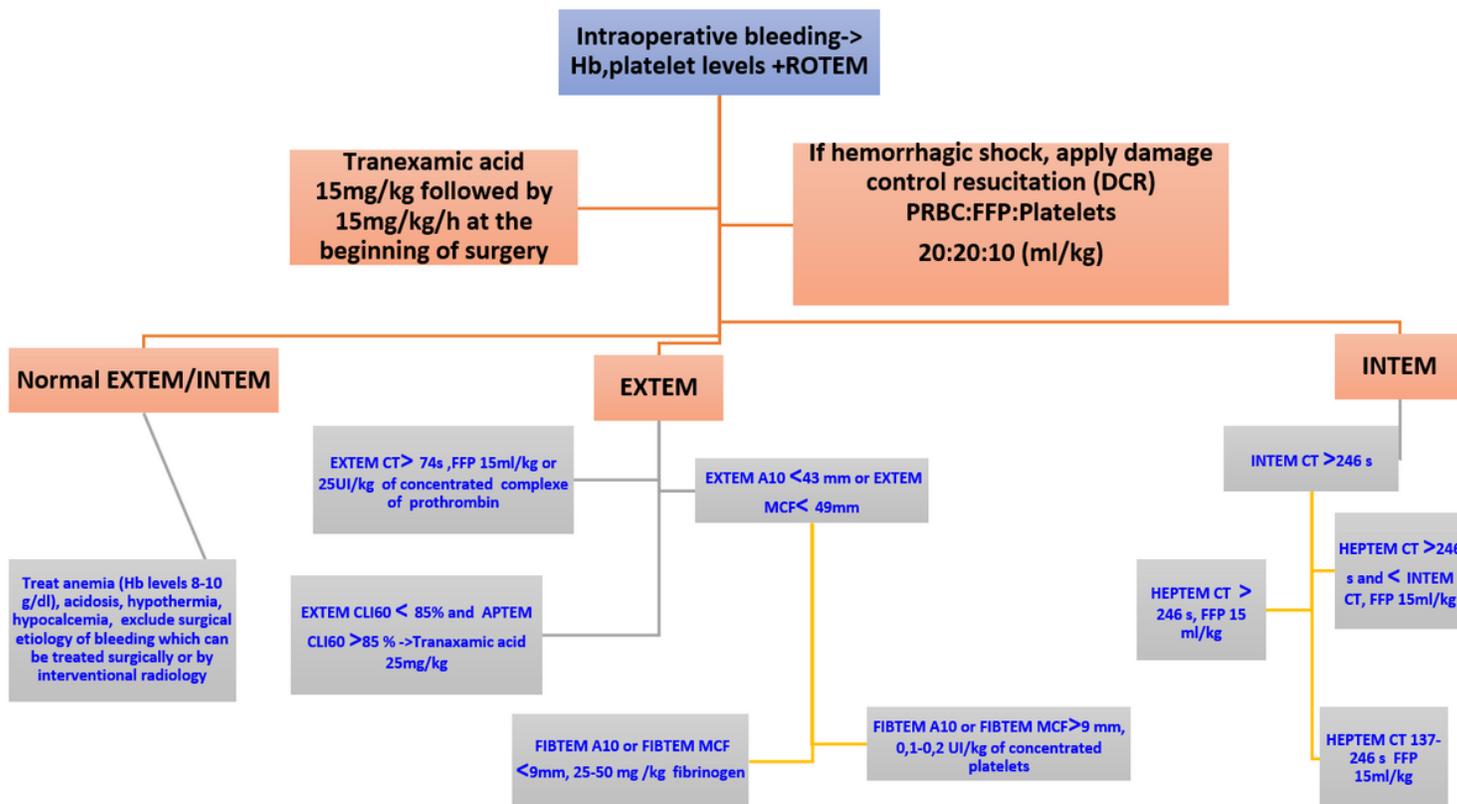


Figure 3

ROTEM Algorithm >16 years. CT=coagulation time in seconds, A10= clot firmness at 10 minutes, MCF =maximum clot firmness, CLI60= lysis index in % 60 minutes after CT, ML= maximum lysis in %, FFP=fresh frozen plasma, PRBC=packed red blood cells, Hb=hemoglobin