10 Orthopaedic Surgery Approach to Damage Control: Decision-Making and Indications

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10.1 Introduction

Decision-making may include several processes, such as assessment of the patient, assessment of the surgeries and the resources required, and the perspective of management. It requires the vision, the knowledge and the skills of an experienced trauma surgeon or of a trained team of specialized surgeons according to the injury pattern. In this line, the concept of the borderline trauma patient respects the fact that the patient status can change over time and may affect the decision-making process. The widely used concept relies on the triad of death and the factor of organ and soft tissue injuries, which may include head, abdominal or chest trauma as well as severe extremity injuries and complex spinal and pelvic trauma. It is interesting to note that the only *evidence-based definition of polytrauma* summarizes a number of parameters rather than just a single one: cofactors were calculated on the basis of a nationwide registry. Five independent physiologic variables were identified as follows: hypotension, level of consciousness, acidosis, coagulopathy and age [1] (Table 10.1 and Fig. 10.1).

Table 10.1 Evidence-based definition of polytrauma

AIS >2 points and at least one of the following covariables
Hypotension (systolic blood pressure <90 mm Hg)
Level of consciousness (Glasgow Coma Scale [GCS] score <8)
Acidosis (base excess ≥6.0)
Coagulopathy (international normalized ratio 1.4/ partial thromboplastin time >40 s)
Age (>70 years)

The measurement of inflammatory markers that highlight patients at risk is helpful in deciding which patients are best served by damage control surgery. The use of a single parameter is inappropriate, as multiple factors can influence the course in multiple ways.

These are best described for the triad of death (shock, hypothermia, coagulopathy):

1. Hypothermia is known to affect coagulation and does not address the clinical situation completely, if addressed alone [2]. It has to be viewed and treated within the general context.
2. Coagulopathy affects several other pathways, such as the cellular energy turnover, the cardiac effects induced by hypothermia. This may not allow for safe definitive surgery (see below) [3].
3. Shock belongs to the triad of death as well, and the parameter used the most is serum lactate. However, care should be taken not to rely on

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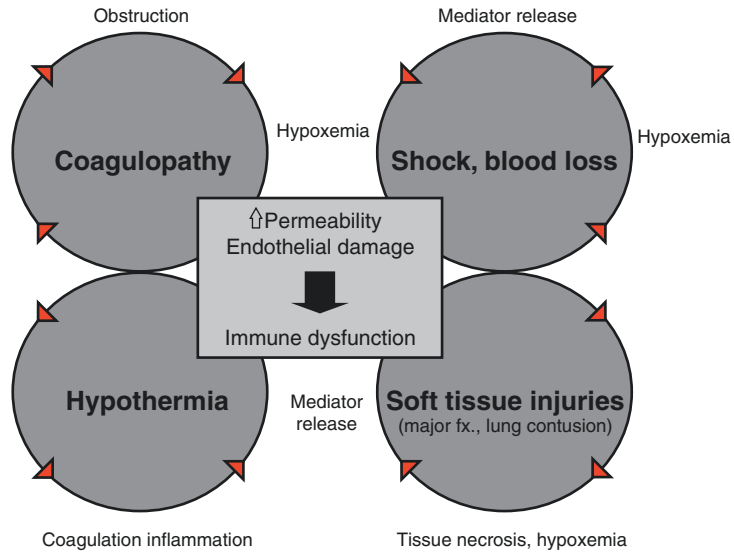

Fig. 10.1 Four vicious cycles

lactate alone: Various metabolites may affect the measurement of metabolic acidosis [4]. Elderly with chronic diseases – such as renal failure – may demonstrate pathological lactate values [5]. These factors contribute to the general inflammatory response after trauma.

4. Soft tissue, respectively, organ injuries of the head, abdomen, chest, spine, pelvis and the extremities are parameters of the first trauma hit that put the patient at risk as summarized below [6–8].

It has also been suggested that patients at risk of adverse outcome, such as those with head injury, bilateral lung contusions, multiple long bone injuries, coagulopathy, hypothermia, or estimated operation time of >6 h, should be considered for sequential staged surgical management [9] (Table 10.2). Markers of the adequacy of shock reversal, such as serum lactate, are measured routinely in trauma centres. It is therefore easy to envisage the routine use of markers of pro- and anti-inflammatory systems such as IL-6, IL-10 and procalcitonin to aid in the decision to carry out damage control surgery. Delaying definitive surgery until the shock state is fully reversed would appear to be not only beneficial but imperative [12].

The Polytrauma Grading Score (PTGS) [9] has reconfirmed that multiple parameters are important, and even in a prospective database analysis, acid-base abnormalities [11] and coagulopathy, the number of pBRCs administered and the injury severity score have been proven to be of value.

Table 10.2 Recommendations to consider damage control within the safe definitive surgery concept

Parameter/clinical diagnosis	Recommendation
Head injury	Degree unclear in the literature, no recommendation possible
Bilateral lung contusions	TTS score [10]
Estimated operation time of >6 h	Includes visceral operations, followed by orthopaedics [11]
Multiple long bone injuries	>2 of the lower extremity
Hypothermia or coagulopathy	Unresponsiveness to resuscitation

Therefore, the decision-making according to the ‘four pathophysiological cascades of polytrauma’ appears to be valuable. The parameters of these four cascades to be remembered could be summarized in the following phrase:

> Soft tissue injuries (major extremity fractures, severe pelvic fractures, spinal injuries especially with spinal cord injury, organ injuries such as head injuries AIS>2 or lung contusions AIS>2), coagulopathy (platelets <90,000) and shock (systolic BP<90 mmHg, requirement of vasopressors) contribute to hypothermia (core temp. <33 °C) and systemic inflammation, and are dangerous. [5]

Ich verstehen das mit dem soft tissue injury nicht, Organverletzungen wie Leber oder Head sind doch auch grosse Risikofaktoren?

10.2 Steps of Decision-Making: Safe Definitive Surgery Concept to Include Damage Control and Early Definitive Care

After the initial assessment is completed using ATLS principles, the treating physician usually gets a fairly good impression about whether the patient is at risk for acute haemorrhage that may lead to lethal outcome [11].

The *safe definitive surgery* concept encompasses both components from early definitive surgery and damage control since the clinical scenario can change rapidly that may require a change in the management [12, 13].

These stages apply for the surgical approach. It is understood that nonsurgical causes of instability have to be addressed in a parallel fashion: these usually imply issues of coagulopathy, hypothermia or any combination of the four pathological cascades.

The patient's condition may range from clinically stable to a state named 'in extremis', where there is imminent danger of death. Fortunately, the majority of patients belongs to the group classified as 'stable' or to the 'borderline' patient group (grade I or II (if stable after resuscitation)) that can be safely stabilized during the course of the emergency treatment.

Stable patients have the physiological reserve to withstand prolonged operative intervention where this is appropriate and can be managed using an early total care approach, with reconstruction of complex injuries.

For the *borderline patient,* primary stabilization strategies may be used but should be undertaken with caution and forethought given to operative strategy should the patient require a rapid change of treatment rationale. Additional invasive monitoring should be instituted and provision made for intensive care unit admission.

To reduce the surgical burden, an unreamed nail may be considered for the femur if possible, and the surgeon should be alert to the possibility of having to convert to the damage control pathway at any time throughout the procedure if the clinical condition of the patient deteriorates, called 'bail-out' procedure.

Treatment in *unstable patients* has evolved to utilize a 'damage control' approach as preemptive intervention. This entails rapid life-saving surgery only as absolutely necessitated and timely transfer to the intensive care unit for further stabilization and monitoring. Temporary stabilization of fractures using external fixation, haemorrhage control and exteriorisation of gastrointestinal injuries where possible is advocated. Complex reconstructive procedures should be delayed until stability is achieved and the acute immunoinflammatory response to injury has subsided. This rationale is intended to reduce in magnitude the 'second hit' of operative intervention or at least delay it until the patient is physiologically equipped to cope.

Conclusion

Decision-making should be performed rapidly and may be subject to revision before, during or after the first surgical phase. Some trigger factors are known that require damage control or abbreviated surgeries. Among these are severe head and chest trauma, multiple fractures if the patient is unstable, or uncontrollable exsanguination due to severe abdominal or pelvic trauma. Damage control orthopaedics is recommended for an unstable patient or a patient in extremis, and it has some utility for the borderline patient as well. Specific injury combinations for which damage control orthopaedics should be considered are femoral fractures, if bilateral, pelvic ring injuries with profound haemorrhage and multiple injuries in elderly patients.

This process of decision-making may be defined as 'injury patient tailored' for damage control orthopaedics, e.g. safe definitive surgery. Regarding this strategy, it continues to be essential to validate prognostic criteria, as achieved in the Polytrauma Grading Score.

Further studies should be fulfilled to better understand the role of damage control orthopaedics in the treatment of patients that sustained a combination of orthopaedic trauma and concomitant injuries to the chest and head.

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