

Choice of Optimal Time and Type of Orthopedic Surgery in Multiple Injured Patients with Acute Respiratory Distress Syndrome (ARDS) Depending on Age: Retrospective Study

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SUMMARY

Background. Multiple traumatic injuries are severe conditions with a high risk of complications. Hemorrhage, multiple organ failure syndrome (MOFS), systemic inflammatory response syndrome (SIRS) and sepsis are the most dangerous sequelae. ARDS (acute respiratory distress syndrome) is a part of MOFS. Despite new strategies of prevention and care, the mortality associated with these conditions still remains high.

Materials and methods. We conducted a retrospective study of the surgical management tactic of 145 patients with multiple trauma complicated by ARDS. All patients were treated in Ivano-Frankivsk Regional Clinical Hospital between 2007 and 2012. There were 118 (81.4%) males and 27 (18.6%) females. Patients were divided into two age groups. Group I consisted of 113 (78%) patients aged 18-64 years, including 106 (94%) males and 7 (6%) females. Group II consisted of 32 (22%) patients over 65 years old, with 7 (21.8%) males and 25 (78.2%) females. AISS-NISS (Abbreviated Injury Severity Score – New Injury Severity Score) scores were 55.9 ± 1.312 in Group I and 54.9 ± 2.43 in Group II.

Results. The difference in emergency surgery timing between Group I and II was not significant ($p > 0.05$). Age was an important criterion in defining optimal time of osteosynthesis ($p < 0.01$). The choice of osteosynthesis type did not depend on patient age in the early period of trauma (1-3 days) ($p > 0.05$), but the surgical tactic was significantly different in the late period (8 days and more) ($p < 0.01$). Active fracture management with a stable osteosynthesis technique (intramedullary nailing, plating and external fixation) was preferred in the younger age group.

Conclusions. 1. The age of the patient is quite an important factor defining the surgical tactic. 2. However, neither age nor severity of injury to the anatomical segments is a reliable criterion for assessing the severity of a patient's condition.

Key words: multiple injuries, acute respiratory distress syndrome, orthopedics, surgical treatment.

BACKGROUND

Multiple traumatic injuries are a severe condition with a high risk of MOFS and ARDS. Although most recent trials tend towards the DCO (damage control orthopedics) conception of surgical management of multiple trauma patients with long bone fractures, some trials prove the benefits of the ETC (early total care) conception.

MATERIALS AND METHODS

Our retrospective study covered the hospital documentation of 145 patients with multiple traumatic injuries complicated with ARDS. All patients were treated in Ivano-Frankivsk Regional Clinical Hospital between 2007 and 2012. There were 118 (81.4%) males and 27 (18.6%) females in the group. The patients were divided into two groups according to age. Group I consisted of 113 (78%) patients aged 18-64 years, including 106 (94%) males and 7 (6%) females. Group II consisted of 32 (22%) patients over 65 years old, including 7 (21.8%) males and 25 (78.2%) females. AISS-NISS (Abbreviated Injury Severity Score – New Injury Severity Score) scores were 55.9 ± 1.312 in Group I and 54.9 ± 2.43 in Group II.

Inclusion criteria:

- Patients aged 18 years or more with multiple injuries complicated with ARDS, including at least one injury to the bones of limbs and pelvis combined with internal organ injury.
- Closed fractures, open fractures or combinations.
- Patient had to undergo at least one surgical procedure (except for diagnostic ones, e.g. intracranial pressure measurement)

Exclusion criteria:

- Injuries of the chest except for superficial wounds of soft tissues;
- Severe brain injuries;

ARDS was diagnosed if the patient met the American-European Consensus Conference (AECC) criteria [3]:

- Acute onset
- Pulmonary artery wedge pressure ≤ 18 mm Hg or absence of clinical evidence of left atrial hypertension
- Bilateral infiltrates on chest radiography
- Acute lung injury (ALI) is present if $\text{PaO}_2/\text{FiO}_2$ ratio is ≤ 300
- Acute respiratory distress syndrome is present if $\text{PaO}_2/\text{FiO}_2$ ratio ≤ 200
- PaO_2 = partial pressure of arterial oxygen; FiO_2 = percentage of inspired oxygen.

In some clinical cases catheterization of a central vein was not performed, so pulmonary artery wedge

pressure was not measured and if there were no signs of left arterial hypertension, the $\text{PaO}_2/\text{FiO}_2$ ratio was assessed as > 300 .

The severity of the multiple injuries was also determined according to the AIS-NISS system [16] in all patients.

We studied the types and time of surgical procedures provided to patients from the moment of trauma. The timing of surgical procedures was following: 1-3 days as the best time for urgent surgery and osteosynthesis according to the ETC conception, 4-7 days – the most inappropriate time for any surgical procedures because of high risk of complications, and 8 days and more as the optimal time for osteosynthesis according to the DCO conception.

The nonparametric χ^2 test was used for the statistical analysis.

RESULTS

A total of 206 surgical procedures were performed in all patients. There were 127 (62.0%) emergency surgeries because of injuries to pelvic and abdominal internal organs, vessel lesions, initial debridement and amputation surgery, and 79 (38.0%) osteosynthesis procedures of the following types: 28 (35.4%) external fixation device (EFD) surgeries, 30 (38.0%) locked intramedullary nail (LIMN) procedures and 21 (26.6%) other procedures. There were 66 (52.0%) emergency surgeries in group I and 61 (48.0%) in group II.

Timing of the emergency surgery was as follows: 37 (29.1%) and 38 (30.0%) procedures between days 1-3, respectively; only 3 (2.4%) in patients from group I between days 4-7; and 26 (20.5%) and 23 (18.0%) on day 8 and later. There was no significant difference in emergency surgery timing between group I and II. This finding suggests that the age criterion did not play the main role in defining indications for emergency surgery because of internal organ injury ($p > 0.05$) (Fig. 1).

Osteosynthesis as a tactic of fracture management was preferred in group I (59 [75.0%] patients) compared to group II (20 [25.0%]). A total of 23 (29.1%) surgeries were performed during the first 72 hours: 21 (26.5%) in group I and 2 (2.5%) in group II. No orthopedic surgical procedure was performed between the 4th and 7th day. After the 7th day, 56 (70.9%) osteosynthesis procedures were performed, with 38 (48.1%) group I and 18 (22.9%) in group II. The following types of osteosynthesis were performed during the first three days: EFD – 18 (22.8%) in group I and 2 (2.5%) in group II; LIMN – only 3 (3.8%) in group I. After the 8th day, the following were per-

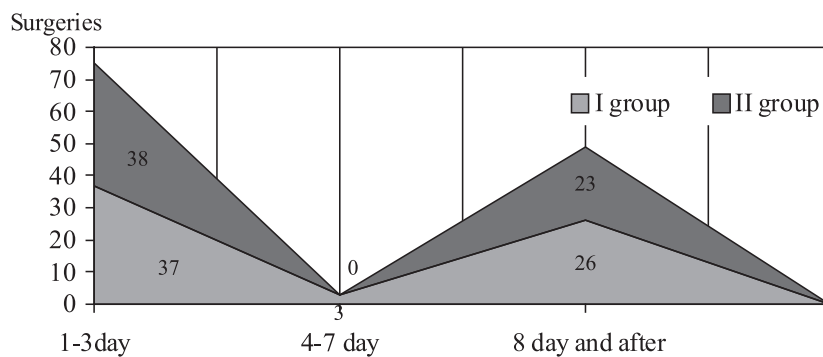


Fig. 1. Timing of urgent surgeries in patients of the group I and II

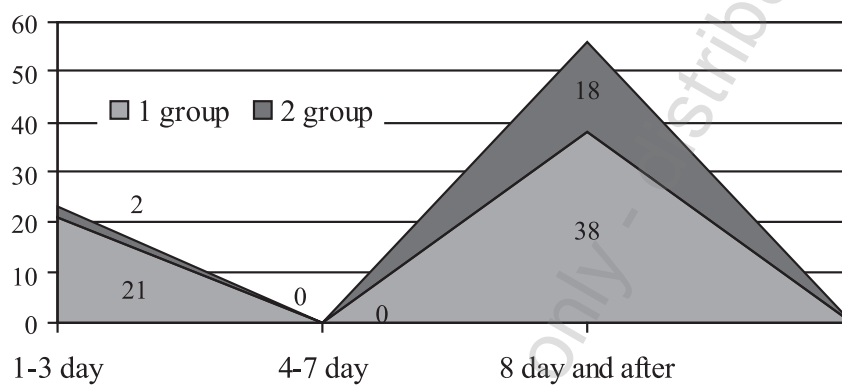


Fig. 2. Timing of osteosynthesis in patients of group I and II

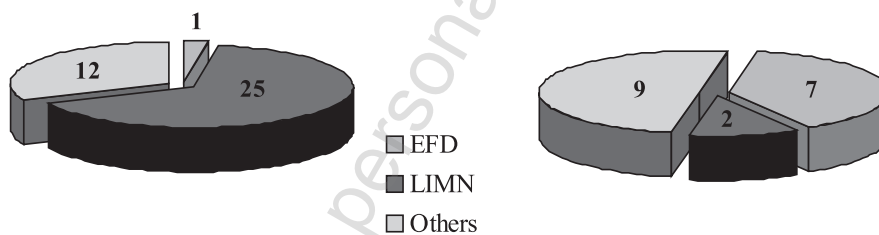


Fig. 3. Types of osteosynthesis in group I (left) and II (right) after 7th day

formed: EFD 1 (1.3%) and 7 (8.9%), LIMN – 25 (31.6%) and 2 (2.5%), others – 12 (15.2%) and 9 (11.4%), respectively.

Therefore the age of patient was an important criterion for defining the time of osteosynthesis ($p < 0.01$) (Fig. 2).

The choice of osteosynthesis type did not depend on patient age in the early period after trauma (days 1-3) ($p > 0.05$). However, the surgical tactic was significantly different in the late period (day 8 and later)

($p < 0.01$). Active fracture management with a stable osteosynthesis technique (intramedullary nailing, plating and external fixation) was preferred in the younger age group (Fig. 3).

Elderly patients (group II) were mostly managed conservatively. Surgery was performed only in the presence of large bone segments of the limbs injury and external fixation or nailing was preferred (Image 3).

As elderly patients are at a high risk for the «second blow» phenomenon, this tactic complied with

the DCO principles. Orthopedic surgical procedures are time-consuming and often traumatic to patients. In order to prevent severe complications, conservative treatment was performed in group II until bodily functions were stable. Then, delayed osteosynthesis was performed if necessary. It is important to consider that early ambulation of the patient is good prophylaxis of many respiratory complications, e.g. ARDS. Unfortunately it is not possible to reach a vertical position without early stabilization of fractures, especially of the femur and pelvic bones.

A reliable scoring system for estimation of homeostasis disorders secondary to trauma is yet to be found.

Determining a proper management tactic in elderly patients is a topical problem, because temporary fixation is not a very good way to achieve bone healing and, on the other hand, early stable osteosynthesis would cause many complications.

DISCUSSION

The frequency of multiple injuries is 8-10% among patients with orthopedic and internal organ injuries [15]. Multiple injuries cause many dangerous complications, such as acute respiratory distress syndrome (ARDS) with respiratory failure which rapidly exhausts the body's mechanisms of compensatory adaptation [10]. According to Hudson et al., ARDS develops in 25% of patients with multiple injuries [11]. Bakowitz and all define trauma as the main predisposing condition in 7% cases of ARDS [2]. Recent USA multicenter randomized trials show the incidence of trauma-related ARDS to be 6.5% of traumatically injured patients [16,19].

Unfortunately progress in intensive care of the last decade has not decreased ARDS-related mortality [5,7].

Modern scale systems, such as the Abbreviated Injury Scale (AIS), Injury Severity Score (ISS), New Injury Severity Score (NISS), Revised Trauma Score (RTS), Trauma Score – Injury Severity Score (TRISS), APACHE II (Acute Physiology and Chronic Health Evaluation II) and SOFA (Sequential Organ Failure Assessment) [1, 9], help to evaluate the severity of the patient's condition (including multiple injured patients), but do not help to make the decision of choosing the proper tactics of general surgical and orthopedic management.

The «early total care» (ETC) conception was developed in the early 80's. It recommended performing surgical management of all injuries, including orthopedic injuries, during the first 24 hours. But practice proved that when employed despite the severity of the patient's condition and prevalence of injuries in

the acute period of following the trauma, this principle often caused death of victims because of severe complications, including ARDS, multiple organ failure syndrome (MOFS), pneumonia, or sepsis. These deaths occurred during the first hours after injury but also during the late period (5th-7th day, «second blow»). This phenomenon has been called the two-hit model of ARDS [4,14,20]. Therefore ETC conception is valid only in not critically ill patients. According to more recent studies [7,18], a chain reaction of predisposing conditions and multiple hits (modifying factors and treatments) in healthy lungs can lead to the development of ARDS. Hudson et al. described eight predisposing clinical conditions (sepsis, aspiration, drug overdose, near-drowning, pulmonary contusion, multiple transfusions, multiple fractures and head trauma) that are associated with the highest risk of acute lung injury (79% sensitivity but only 26% specificity). Other trials showed lots of factors, but none has enough sensitivity [7] and could help to identify patients at risk for ARDS.

The state-of-the-art conception of management of severely injured patients with polytrauma is «damage control orthopedics» [6,18]. It means advance management, with the most urgent steps being emergency live-saving surgery (e.g. decompression trepanation, stopping an internal hemorrhage, etc.) and temporary stabilization of big bone fractures (such as femur) by external fixation devices. If the patient's condition is stabilizing, a secondary definitive procedure of osteosynthesis is performed (after 5 days) [8, 12,13]. This tactic has reliably improved the results of treatment of severely injured patients with polytrauma and helps to save the lives of numerous trauma victims.

There is still no clear evidence for the superiority of one of the surgical management tactics in multiple injured patients. On the one hand, ETC has benefits like fewer surgeries, shorter hospital stay, etc. On the other hand, some trials have shown the definite treatment strategy (DCO) in patients with multiple injuries to lower overall mortality. Since the objective criteria of orthopedic management of bone fractures in multiple injured patients are not clear yet, the surgeon has to make a decision based on his or her own experience.

CONCLUSIONS

1. A thorough examination of the patient significantly influences management according to the DCO conception. It helps doctor to be guided not just by personal experience, but also by objective criteria in order to choose a timing and type of

osteosynthesis and so prevent severe complications like ARDS.

2. Patient age is quite an important factor defining the surgical tactic. However, neither age nor severity of injury to the anatomical segments is a reliable criterion for assessing the severity of a patient's condition.
3. More studies of the effect of the «second blow» phenomenon on MOFS and its part ARDS need to be carried out in order to establish reliable criteria for assessing the severity of the condition of multiple injured patients and choosing the most appropriate orthopedic management. In the nearest future, the high risk of death criteria in multiple injured patients have to consider not only anatomical injuries but also functional disorders, such as systemic cytokine response, immune and coagulation imbalance, which are the main triggers of MOFS.
4. To choose a proper tactic for each multiple injured patient, the following needs to be determined:
 - severity of the entire trauma («first blow») and its influence on the body (detailed laboratory and x-ray examination);
 - patient characteristics (age, concomitant diseases),
 - quantity, duration and invasiveness of orthopedic surgery («second blow»).

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