

**UNIVERSITY OF MEDICINE AND PHARMACY
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DOCTORATE THESIS

*Polytrauma with injuries to the musculo-skeletal system – clinical and
therapeutical aspects*

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Craiova

2014

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Polytrauma cases are approximately 16-18% of all traumatic pathology worldwide and still have a high mortality rate (15-50%), being the leading cause of death for population under 40 years and the third major cause of death for all ages. Polytrauma affects mainly the most active and economically productive. Although the social impact is evident, in many countries, including our country, polytrauma gathers insufficient fundings for treatment, therefore is considered to be "the neglected disease of the modern society". Moreover, 90% of polytrauma are encountered in developing or under developed countries and their incidence is still growing, thus making polytrauma a major health problem in many countries, including our own.

Studies have shown that 30-40% of polytrauma mortality can be corrected by the simple existence of specialised trauma centers evenly spread in a well defined population.

Although the mortality in polytrauma with extremity and pelvic injuries is the lowest of all anatomical regions (cranio-cerebral, thorax, abdomen), the subsequent disabilities, mainly because of injuries to the lower limbs, are the main concern of the patients.

Having considered all these problems, I have tried to make a retrospective and comparative study between two regional emergency hospitals, Craiova and Floreasca, and three speciality clinics (two of General Surgery and one of Orthopedics) with a great experience in the treatment of polytrauma.

The study is trying to identify the etiopathogenic factors involved in polytrauma and to correlate their influence with the severity and lesional anatomic topography in the presented cases. Also, lacking national treatment guidelines, this study tries to apply the local therapeutic possibilities in international diagnostic and therapeutic guidelines.

Polytrauma is a serious pathological condition resulting from the action of one or several vulnerable (mechanical, physical, chemical, etc.) agents which, by simultaneously acting for a brief period of time on multiple anatomic areas, generate at least two major traumatic injuries, at least one being of immediate or subsequent vital risk, and produce a severe clinical syndrome, related to a systemic inflammatory response for a minimum of 24 hours, with major organ disfunctions or failures, even in the absence of a direct effect.

Thus, polytrauma results in a complex physiopathologic syndrome, always accompanied by shock, with unpredictable evolution, consisting of specific regional clinical syndromes causing effects of amplification, subtraction and addition that enhance each other in an aggravating manner.

The above paragraphs include all anterior attempts to define polytrauma: the topographic addition of several traumatic lesions that simultaneously influence each other and are always accompanied by shock, with at least two major anatomic regions injuries and at least one lesion with a vital risk or a patient with ISS \geq 16.

The victims of these simultaneous and multiple injuries, with a complex etiology and topography, have a synthesis of pathogenical aspects of the anatomic systems involved and fuel particular systemic reactions which aggravate each other, resulting in infinite anatomic and clinical combinations.

If the 4 main anatomical regions of the body are considered (H – head, T – thorax, A – abdomen, L – limbs) there can be 11 lesional combinations. In reality, the combinations are practically unlimited; if trauma scales and body reaction to trauma are used, the polytrauma can be more accurately described. Accordingly, the polytrauma description can be changed from a simple sum of lesions to notions that show the relations between the functional lesions, for instance the notion that at least one lesion can be lifethreatening or the intensity of the systemic inflammatory response or the lesions gravity scales (ISS).

Biregional polytrauma with injuries to abdomen and limbs (AL), although they do not directly affect major organs, can compromise vital functions (breathing and circulation) by the haemorrhagic shock they induce due to their association with lesions of the abdominal organs, open fractures of the limb with major vessels injuries, fractures of the pelvic ring or sepsis secondary to lesions of the bowels; also they can be associated with a difficult recovery period or disabilities of the musculo-skeletal system.

Fractures of the pelvic ring have attracted in the last decades a growing attention due to the increase of their incidence, lesional gravity and medical resources they consume for treatment. This attention has led to a better knowledge of their etiopathogeny, classifications and treatment guides. Because fractures of the pelvic ring frequently happen in association with polytrauma (20% of all polytrauma have pelvic fractures), these two entities cannot be isolated analysed. The modern classifications and treatment guidelines present only general principles, the individual therapeutic decision must be linked to the particularities of the patient. The association of the fractures of the pelvic ring with abdominal organs lesions and with fast and hidden bleedings is a bad situation and it creates an entity with several components that aggravate each other, fact proven by the increased mortality and morbidity rates.

The fractures of the inferior limb are a serious factor in the prognosis of the polytraumatized patients because they increase the social rehabilitation and recovery period. Although some patients do obtain the full recovery of the joint mobility in the first months after trauma, in most cases it is necessary a longer time period to correctly evaluate the permanent consequences of these injuries. The studies show that the cumulative percent of the patients with injuries to inferior limbs that come back to work has a growing trend up until 30 months after trauma and the inferior limb disabilities are the main cause of concern of the patients evaluated after 2-3 years after trauma.

Starting from the facts listed above, I have chosen the focus of the present thesis polytrauma with injuries to the musculo-skeletal system, having the following objectives:

- the evaluation of the impact of musculo-skeletal injuries in polytrauma, both in the anatomical distribution of all injuries and in the appearance and evolution of the complex clinical aspects of polytrauma
- the development of a diagnosis and therapeutic guideline of polytrauma associated with injuries to the musculo-skeletal system that might improve the

prognosis and the favourable evolution and that might decrease the economic costs of these cases.

To accomplish these objectives, I have made a retrospective, multi-centre study that was conducted on a number of 208 polytraumatised individuals, split in two groups, hospitalised and treated in the General Surgery Clinic of the Floreasca Hospital of Bucharest and in the Surgery Clinic 1 and Orthopaedics Clinic of the Clinical Emergency Hospital of Craiova. The two groups were made of:

- group I (Floreasca) 100 patients hospitalized and treated in General Surgery Clinic of the Floreasca Hospital of Bucharest between may 2011 – may 2012
- group II (Craiova) 108 patients hospitalized and treated in the Surgery Clinic 1 and Orthopaedics Clinic of the Clinical Emergency Hospital of Craiova between 2009-2011.

The etiological circumstances of the occurrence of polytrauma systematised in literature are: traffic (road, air, rail, maritime) accidents, labour (industry, agriculture, constructions, commerce, etc.) accidents, vehicle – and/or hetero-aggressions, accidental precipitations or as a result of some aggressions, domestic accidents (accidental falls, blows with a hard object), recreational sports or play accidents, war traumas and natural disasters.

In our study, road accidents were also the main etiological factor of polytrauma totalling 67.0% in the Floreasca group and 68.5% in the Craiova group, with an average of 67.78% in both groups, with a maximum incidence between the ages of 20 and 50, the injured individuals being drivers, passengers or pedestrians.

Labour accidents were encountered only in 4.80% of the cases (10 cases, 7 in the Floreasca group and 3 in the Craiova group), all being caused by falls from heights or crushing, which caused cranial-cerebral, thoracic and/or abdominal severe injuries, fractures of the pelvis, spine or limbs in almost all cases.

Falls were the cause of polytrauma in 41 (19.71%) of the cases (17 in the Floreasca group and 24 in the Craiova group) and occurred at the same level in 12 cases and from a height exceeding 2 m in 29 cases, the lesional balance being different for the two types of falling: fractures and / or various joint dislocations associated with cranial-cerebral trauma for the falls from the same level and a more complex lesional balance for the falls from height (precipitations) to which, besides the height from which the fall is caused, a number of gravity factors are related: the speed at the moment of the impact, the anatomical area of impact and impact surface.

Physical aggressions were encountered in 16 cases representing 7.69%.

Age represents an etiopathogenic factor to be taken into account in the evaluation and management of polytraumatised patients, because, for identical traumatic factors, such as intensity, duration and way of action, the effects are very much dependent on the age of the patient. Thus, children and young people bear trauma much easier due to a greater flexibility of their skeleton, however, for the elderly, although the incidence of polytrauma is smaller, for the same lesional balance, mortality is much higher and disproportionate in relation to the severity of the injuries (5 times higher for the patients over 70) because of the decrease in the

visceral biological reserves and increased risk of complications presence of associated pathology: cardiovascular diseases, osteoporosis, lung diseases, metabolic and nutritional changes, senescence of the immune system.

The incidence of polytrauma related to sex ratio has shown, according to literature, that mainly men are affected (sex ratio = 4/1 for the Floreasca group and 2.37/1 in the Craiova group) due to their more intense daily activity, much more exposed more to risk factors, as well as due to their involvement in armed conflicts or individual aggressions. On the other hand, gender is also a factor of differentiation; although they have a higher weight and implicitly a higher inertia during the accident, men also have a heavier skeleton and stronger musculature, which makes them more resistant to any kind of impact.

Alcohol and drugs are on the one hand factors leading to polytrauma and, on the other hand, they are factors aggravating the subsequent evolution by changing the post-trauma physiopathologic response. In England, alcohol is considered to be responsible for 35% of the road accidents and 10% of the total visceral lesions and 1/3 of injured pedestrians were under the influence of alcohol; 1500 deaths/year are attributable to alcohol in the same statistics, of which 620 drivers, 480 pedestrians and 400 innocent victims. We have identified alcohol consumption in only 7% of all road traffic accidents.

The frequency of the anatomic areas interest in road accidents is different and there is great variability depending on the author, probably mainly due to the demographic indicators with correspondent in the local legislative road safety rules: 40-70% craniocerebral trauma, 9-26% facial traumas, 44-62% chest traumas, 44-45% fractures of the inferior limbs, 25-30% fractures of the upper limb, 2-13% neck lesions and 2-3% spine lesions.

The data gathered in this study is between these limits, with the exception of the abdominal trauma, which are more frequent, probably because of the way the patients were selected.

Head trauma was present in over 50% of the cases (115 cases), with close values between the two groups, gives polytrauma a high vital risk, the cranio-cerebral lesions being present in 14 out of 29 deaths in the personal study.

Thoracic injuries were present in 54.89% (114 cases) of the patients, also with close values between the two groups. They determine a high severity of the trauma because the traumatic agent is guided over a region that protects vital organs (heart, lungs) and can start, in any moment, specific physiopathological syndromes that affect vital functions (circulation, breathing) and have an serious on-going potential.

The abdominal visceral injuries were encountered in 96 polytrauma (46.15%), single (58 cases) or multiple (38 cases) organs being involved. In 79 cases the injuries were present to solid organs, in 27 cases to cavitary organs and in 14 cases to the urinary system (20 cases). Retroperitoneal hematoma was encountered in 25 cases, the source of bleeding was injuries to major blood vessels, kidneys or pelvic fractures.

The musculoskeletal system injuries were present in 65.36% (136) of the cases, being present in all quadri-regional trauma, in 75.94% of all tri-regional trauma and in 64.46% of bi-regional trauma. 14 cases (6.73%) were contusions, sprains or dislocations and 122 cases (58.65%) with fractures, out of which 32 cases had injuries of upper limbs, 35 cases of pelvis, 75 cases of the inferior limbs and 11 cases of the spine.

A particular attention was given to the pelvic fractures that have a high risk due to the haemorrhagic shock they may induce by blood losses in the fracture site that can be up to 2000 ml, with a massive retroperitoneal haematoma and, also, due to the traumatic lesions associated with important forces that led to the disruption of the pelvic ring. In our study, the frequency of the lesions associated with pelvic fractures was: 55.5% head trauma, other fractures 44.4%, neurological injuries 5.55%, thoracic trauma 50%, urethral lesions 11.1%, bladder injuries 13.89%, spleen lesions 16.67%, liver ruptures 13.89%, digestive system injuries 13.89%, kidney injuries 7% and diaphragm injuries 8.33%.

The treatment of musculo-skeletal injuries was conservative and/or surgical, the choice and timing of the therapeutic method being adjusted by the order of the vital risk lesions and by number, type, topography and severity of the fractures.

The management of the musculo-skeletal injuries has a particular order of the treatment, even if they are considered to be II and III degree on the severity scale AIS (Abbreviated Injury Scale) and not one of the major surgical emergencies: open fractures of the limbs and pelvis, compartment syndrome, fractures with major neurovascular injuries (myelical fractures of the spine, neurovascular injuries of the limbs and pelvis), articular fractures, dislocations and fractures of the long bones.

In principle, in modern traumatology, two therapeutic attitudes are outlined, the choice of each one of them depending on the morphological characters of the fractures (number, topography, type, etc.), age, general status, type and severity of the associated lesions and the equipment of the service and competence of the team providing assistance to polytraumatised individuals:

- sequential surgeries, respecting the priority order of the injuries depending on their vital risk (Damage Control Orthopaedics – DCO)
- simultaneous surgeries conducted by several surgical teams, along with a sustained deshocking therapy, a behaviour that tends to settle early and definitively as many or all of the injuries of the polytraumatised individual (Early Total Care – ETC).

In polytrauma patients, depending on the general status of the patients and on the severity of the fractures and of the associated injuries, there is the possibility to choose between ETC and DCO, reducing the surgical stress, the intra and postoperative complications for a patient with multiple injuries with vital risk that can badly influence the prognostic of the patient.

Thus, if the patient's status is stable, balanced haemodynamically and cardio-respiratory, ETC is recommended (osteosynthesis), with orthopedic surgeries that can be done in relatively safe conditions. If the general status is uncertain, unstable haemodynamically or severe, DCO is recommended until the vital functions are

stable, treating first the associated injuries with major vital risk and after, in the secondary-tertiary period, treating the injuries to the musculo-skeletal system. With DCO there are many temporary orthopedic treatment options until the definitive solution of the injuries that include cast or splint immobilization of the fractures or continuous skeletal traction.

In the personal study, 44 (32.35%) cases were treated conservatively through orthopedic methods, the type of the procedure depending on the type and topography of the fractures. The methods used were: orthopedic reduction of the fracture and cast or splint immobilization for the fractures of the upper limb, toraco-brachial bandage for fractures of the clavicle and scapula, acromio-clavicular or shoulder dislocation, rest in bed for undisplaced pelvic fractures and continuous skeletal traction for fractures of the acetabulum or tibial fractures.

78 (57.35%) cases were operated, the type and material osteosynthesis used depended on the type and topography of the fracture, the medical equipment of the ward and the competence of the surgical team. Except for the open fractures which are surgical emergencies due to high risk of sepsis and, in principle, should be solved in the same session with the vital risk injuries of the thorax or abdomen, in the other cases osteosynthesis can be delayed until the patient is clinically and biologically stable and the fracture can be temporarily immobilized. In these situations, 35 cases were operated immediately and 44 cases had delayed operations.

In 25 cases, the surgical interventions were performed for open fractures. In 2 cases out of 25, thigh amputation was the surgical treatment due to the severity of the injuries.

Out of the 20 open fractures operated immediately, 3 were in the Floreasca group (1 femur, 1 tibia, 1 radius) when external fixation was performed; in the rest 17 cases (Craiova group), the open fractures had the following location: 2 pelvis, 2 humerus, 5 femur, 8 tibia and 1 ankle, in one case there were 2 open fractures in the same patient (femur and ankle on the same side). In the 17 cases, the treatment was osteosynthesis in 13 cases and thigh amputation in 2 cases. In other 2 cases of open fractures of the pelvic ring, the fractures were treated conservatively, but the patients had operations for the abdominal injuries.

In the 13 cases where osteosynthesis was performed, the choice of the implant was external fixator in 2 cases (tibial fractures), centromedular nailing in the other 11 cases: unlocked Kuntscher nail in 5 cases (1 femur, 4 tibia), locked Kuntscher nail in 4 cases (2 femur, 2 tibia) and elastic Ender nails in 2 cases (2 humerus).

In the other 53 cases of closed fractures, in 14 cases (4 in the Floreasca group and 10 in the Craiova group), the surgical intervention was performed as an immediate emergency: In the Floreasca group there were 2 cvadri-regional polytrauma cases (an unstable pelvic fracture stabilised with external fixation and a femur fracture stabilised with a locked centromedular nail) and 2 tri-regional polytrauma cases (ATL and HTL) with fractures to both tibia and peroneum, with patients in an intermediary, but stable, general state. In the Craiova group, the 10 cases operated were performed for 1 fracture of femur with fracture-dislocation of the

metatarsal bones I-IV on the same side, 1 unstable fracture of the spine with an unstable pelvic fracture, 1 severe sprain of the knee, 3 cases with fracture of femur and fracture of the tibial plateau on the same side, 1 fracture of femur and fracture of patella on the same side, 1 case with fracture of tibia and multiple fractures of the metatarsal bones IV and V and 2 cases of diaphysis of femur and tibia fractures on the same side.

44 cases were operated as a delayed emergency. In 39 cases (29 in the Craiova group and 10 in the Floreasca group) the surgical treatment was performed after 1-21 days posttrauma, with an average of 8.47 days for Craiova group and 6.85 days for Floreasca group. In 10 cases of the Craiova group and 1 case in the Floreasca group, the surgical intervention was made in the interval 2-4 days after trauma.

The results found are close related to the ones of the literature: good evolution in 79.4% of the cases, postoperative morbidity 20.08% and global mortality 13.94%. The close analysis of the mortality rate has shown us several interesting aspects:

- the mortality rate was different for the patients that were treated conservatively (9.52%) and surgically (13.49% - 17 deaths). 3 of the deaths had lesions to the musculo-skeletal system when the surgical orthopedic intervention was performed together with the surgeries for abdomen and thorax lesions;

- the cause of polytrauma for the deceased patients was a road traffic incident in 23 cases (79.31%) and 19 were pedestrians, 1 driver and 3 passengers;

- the musculo-skeletal lesions were present in 20 (68.9%) of the deceased patients;

- the mortality rate was related with the severity of the polytrauma: 4.13% in bi-regional cases, 13.92% in tri-regional polytrauma and 21.73% in the cvadri-regional polytrauma.