

DAMAGE CONTROL SURGERY FOR FEMORAL FRACTURES IN POLYTRAUMA PATIENTS

OLIVERA LUPESCU¹, GHEORGHE ION POPESCU², MIHAIL NAGEA³, PAUL NICULESCU⁴,
DORIANA LUPESCU⁵, DAN SUCOVESCHI⁶, ALEXANDRU DIMITRIU⁷

¹“Carol Davila” University of Medicine and Pharmacy Bucharest, ^{2,3,4,6,7}Clinical Emergency Hospital Bucharest, ⁵Buftea Hospital, Buftea

Keywords: polytrauma, trauma score, damage control, femoral fracture

Abstract: Treating femoral fractures in polytrauma patients remains challenging, as avoiding the “second hit” phenomenon which might be induced by femoral stabilization means choosing the proper moment and method for it. Everybody agrees that early fixing in polytrauma patients is of significant benefit, but debates still persist about the method of performing it. This has changed during the last years, from primary nailing, called Early Total Care (ETC) to a sequential method called Damage Control Orthopaedic Surgery (DCOS) - initially less risking external fixation, followed by intramedullary nailing after patient’s stabilization, especially in polytrauma patients at risk of organ failure. The benefit/risk ratio of each method can be evaluated by the incidence of local and systemic complications, especially multiple organ failure and death.

INTRODUCTION

The importance of femoral fractures in polytrauma is demonstrated by including their early stabilisation in “resuscitative measures”, due to the magnitude of the imbalance they produce (bleeding up to 1 500 ml, nociceptive stimuli, high thrombo-embolic risk).(1) In order to avoid enhancing the initial severe imbalance induced by the trauma itself, maximum efficacy with minimum aggression will be the motto of choosing between several surgical methods. The first one is primary intramedullary nailing, called Early Total Care (ETC) which has the advantage of just one surgical procedure, but it has an increased risk of aggravating thoracic and brain injury due to bleeding and embolic risk. On the opposite side, the sequential method, Damage Control Orthopedic Surgery (DCOS) means stabilising the fracture in the first step by a less invasive procedure (external fixation), followed by definitive intramedullary nailing when the patient is stable enough so to stand to a more invasive procedure.(2,3)

PURPOSE

The purpose of this paper is to evaluate the outcome of the patients treated by these methods, so to improve the results of clinical practice and diminish mortality and morbidity in polytrauma patients.

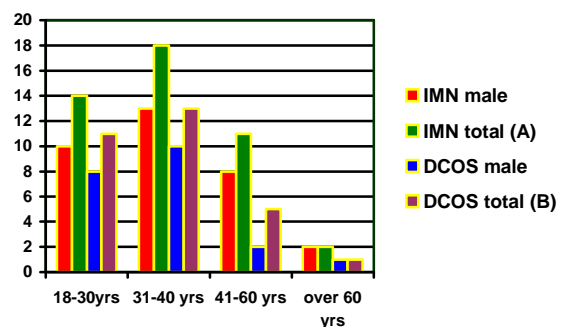
METHODS

This retrospective study evaluates polytrauma patients with femoral fractures treated in our hospital between 1.01.2008-1.06.2013. The inclusion criteria were: skeletally mature patients, with injury severity score (ISS) over 16 and closed femoral fractures, who completed the 12 months follow up, thus selecting for this analysis 75 polytrauma patients with femoral fractures, who were divided into two groups: group A, 45 patients, for whom ETC was chosen, so intramedullary nailing (IMN) was performed, and group B, 30 patients, treated by Damage Control (DCOS). The criteria used for the two groups were: age, gender, type of fracture, trauma score,

associated injuries, rate of multiple system of organ failure (MSOF), of ARDS and local complications (wound infections, pin track infections, implant failure, non-unions).

As it is shown in figure no. 1, most of the patients from the two groups were males, concordant with the fact that this type of injury results from a high energy trauma, males being exposed to such trauma more frequent than women. From the 75 patients, 69 suffered a road traffic accidents: 13 pedestrians; 19 passengers in a vehicle suffering a frontal collision; 29 drivers of a vehicle suffering a frontal collision; 8 patients were riding a bike or motorcycle, while the rest of 10 patients fell from height.

Figure no. 1. Age and gender in group A and B



The importance of these data is considerable, since they demonstrate, consistent with other papers, that the importance of high energy trauma for society is outstanding, as young, active people are the most affected; regardless of the type of accident, considerable energy is necessary so to produce a femoral fracture, due to the high resistance of this bone, so clinical judgement suggests that associated injuries are to be searched whenever a femoral fracture is diagnosed.

¹Corresponding author: Olivera Lupescu, Calea Florească, Nr. 8, Cod, 014461, București, România, E-mail: olivera_lupescu@yahoo.com, Phone: +4021 5992300/308

Article received on 02.12.2014 and accepted for publication on 02.02.2015
ACTA MEDICA TRANSILVANICA March 2015;20(1):90-93

CLINICAL ASPECTS

The fractures were described according to the AO classification (figure no. 2), as being type 3 (femur) 2 (diaphysis), and, what is to be underlined, is that only 8/ 75 (10.66%) are type A, while the rest are type B- 22/75 (29.33%) and C – 30/75 (40%).

More than that, as it can be seen in figure no. 2b, there is an increased proportion of comminuted fractures, characteristic for high energy trauma, and a lower incidence of spiroid fracture, since most of the trauma were produced by a direct mechanism, not a rotational one.

Figure no. 2. AO classification of femoral fractures (a) and type of fractures in the study group (b)

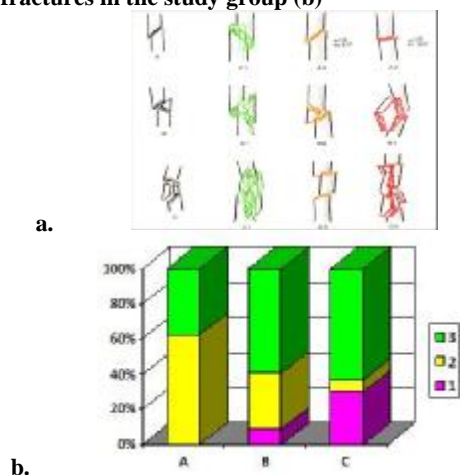
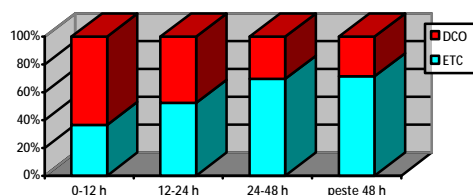


Figure no. 3. Time from trauma to surgery



Another criterion used for evaluating the study group was the time between trauma and surgery, which is the sum between two intervals:

- trauma - admission in our hospital and
- admission-surgery

From the beginning it must be underlined that all the patients were operated for the femoral fracture during the first 10 hours after arriving in our hospital, mean time between admission and surgery being 4.6 hrs.

Since there were patients who were sent to our hospital late after trauma, figure no. 3, representing the time between trauma and surgery, contains some patients operated after more than 24 hours, and, as it can be seen, there is a slight increase of using ETC in patients operated later than 24 hours. There are two facts explaining this:

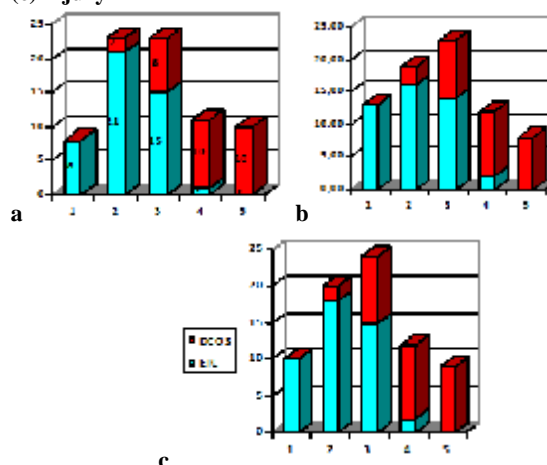
- first of all, as described above, these are patients who arrived at our hospital late after trauma, so, no matter if they are operated immediately after being admitted in our hospital, there was still a delay from the moment of trauma.
- secondly, if the patient was stable enough as for the femoral stabilization to be postponed, that meant that the status of the patient allowed the delay.

Since it represent the base to calculate ISS (the currently used score defining polytrauma) (4), AIS (Abbreviated Injury Score) was used to describe the severity of the injuries in

both groups. Figure no. 4 represents the AIS for the thoracic (a), abdominal (b) and brain (c) injuries, and it is clear that the type of treatment for the femoral fracture was influenced by the severity of associated injuries.

That is, ETC was primarily indicated in patients with AIS 1 and 2 for thoracic, abdominal and brain injury, while DCOS was the method of choice when AIS was 4 or 5; in patients with AIS 3, ETC and DCOS were chosen almost in the same proportion.

Figure no. 4. AIS for thoracic (a), abdominal (b) and brain (c) injury



This is concordant with the data presented in the literature, which classify polytrauma patients in stable, borderline, unstable and in extremis, and recommend that ETC should be used for stable patients, while DCOS would be the most protective method for unstable patients, while debates still exist for the borderline group. The outcome of the patients in order to see the results of either ETC or DCOS was evaluated by analyzing: rate of death, MSOF, of ARDS and local complications (wound infections, pin track infections, implant failure, non-unions).

The rate of ARDS was:

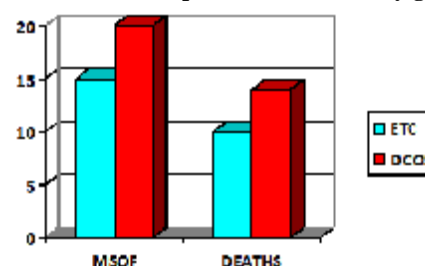
- group A- 4 patients (10%), 1patient out of 40 developed MSOF and died;
- group B- 6 patients (17%), 3 of them also developed MSOF and died.

The rate of MSOF had the same aspect and did not show significant differences between the two groups:

- group A, ETC, 6 patients, meaning 15%, with 4 deaths (10%);
- group B, 7 patients (20%) with 4 deaths (14%).

Figure no. 5 represents the outcome of the patients and it must be understood through the point of view that: *although the patients from group B had considerably higher trauma scores, the outcome was not significantly worse than that of the patients from group A.*

Figure no. 5. General complications in the study group



CLINICAL ASPECTS

With other words, although the severity of the initial injuries was considerably higher in group B, these patients did not develop general complications in a “parallel manner” to this aspect; neither MSOF nor deaths did not increase in group B, despite the fact that most of the patients from this group had a 4 or 5 AIS at the initial evaluation, so we can conclude that using Damage Control for treating the femoral fracture was the least invasive method and protected these patients for any further damage.

As for the local complications, figure no. 6 shows the number of cases in both group A and B; as shown, we cannot consider their incidence as being influenced by using sequential method (external fixation followed by intramedullary nailing) as a primary stabilization method.

Figure no. 6. Local complications

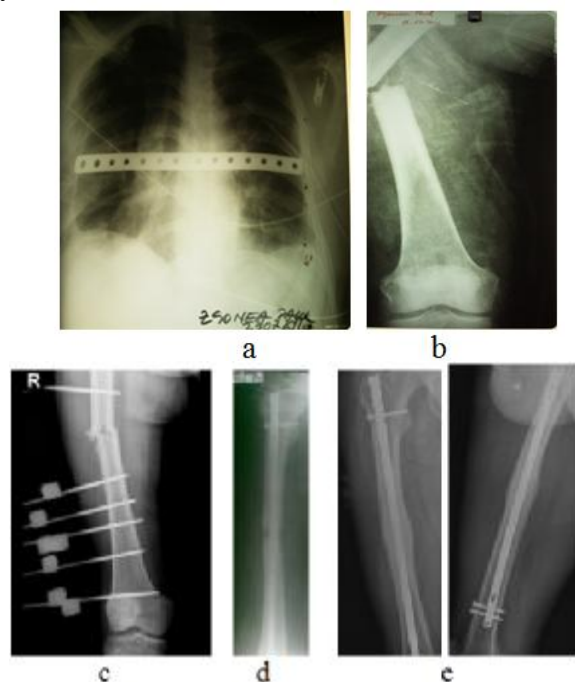
	Wound infections	Pin track infections	Osteitis	Implant failure
ETC	2		1	1
DCOS	2	2	2	1

Two cases are presented for illustrating the idea that DCOS is a valuable method in borderline or unstable polytrauma patients.

First case, male, 48 yrs old, arrived at our hospital 4 days after the initial injury with closed cranio-cerebral trauma (AIS=3), thoracic trauma- haemopneumothorax; multiple bilateral rib fractures with acute Respiratory Failure (AIS=5), cardiac contusion (AIS= 3), liver contusion (AIS=3), right femoral diaphyseal fracture and contaminated wound right ankle.

Damage Control was indicated and external fixation of the femoral fracture was performed. The outcome was slowly positive, with respiratory failure remission, when the patient was extubated. After amending the general status, intramedullary nailing was performed, with no local and general complications. (figure no. 7).

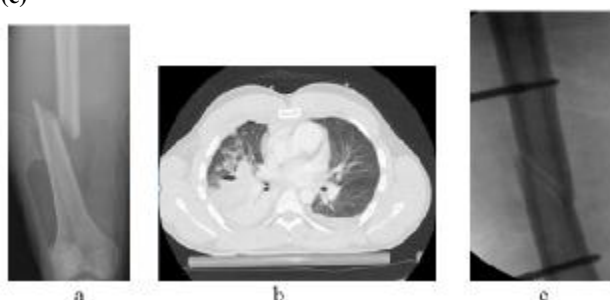
Figure no. 7. Case 1 – DCOS - Thoracic injury (a) AIS 5, femoral fracture (b) initially stabilised by ExFix (c), followed by nailing (d) fracture 1 year after initial trauma (e)



The second case presents a patient, 23 yrs old, polytrauma with abdominal (AIS=3) and thoracic trauma (AIS=5) with femoral fracture. Damage Control was used, with external fixation of the femoral fracture (figure no. 8).

The outcome of the patient was favourable, but quite slowly, since the CT performed 6 weeks after trauma still revealed pulmonary sequelae (figure no. 9a); definitive stabilisation was postponed, CT was again performed after 1 month, when it showed complete remission of the pulmonary trauma, ExFix was removed (figure no. 9b) and an intramedullary nail was introduced (figure no. 9c), with no local or general complications.

Figure no. 8. Case 2 – DCOS - Femoral fracture (a) in a patient with severe thoracic injury (b) externally stabilised (c)



The outcome of the patient was favourable, but quite slowly, since the CT performed 6 weeks after trauma still revealed pulmonary sequelae (figure no. 9a); definitive stabilisation was postponed, CT was again performed after 1 month, when it showed complete remission of the pulmonary trauma, ExFix was removed (figure no. 9b) and an intramedullary nail was introduced (figure no. 9c), with no local or general complications.

Figure no. 9. Thoracic sequelae still visible on CT after 1 month (a) fracture after ExFix removal (b) and after definitive stabilisation (c)



DISCUSSIONS

Any trauma produces the so called “Systemic Post-Aggression Reaction”, which is induced on a neuro-hormonal base, and is centred by inflammatory mechanisms. In polytrauma, this reaction is not a sum, but a result of the interactions between the reactions produced by each injury, but the main negative consequence is the Systemic Inflammatory Response Syndrome (SIRS).(5,6) Any supplementary trauma (including bleeding, infection, massive surgery) aggravates SIRS and can produce MSOF and death, thus being called the “second hit”, after the “first hit” represented by the initial trauma.(7)

Reversely, in order for the SIRS to disappear, the polytrauma patient must not be supplementary aggressed, which is an idea influencing the treatment as following: after the initial life-saving measures, which are mandatory, the team treating the polytrauma patient must establish the treatment for the associated non-life-threatening injuries; the moment and the

CLINICAL ASPECTS

type of these therapeutic measures must be in such a way that they do not represent a "second hit".(8,9)

On this principle, Damage Control was introduced by a therapeutic alternative in order to protect the polytrauma patients (especially borderline and unstable) from the negative effects of an invasive surgery representing a "second hit". Applicable to all organs and systems, Damage Control refers, from an orthopedic point of view, to femoral and pelvic fractures, both representing haemodynamically significant fractures, and consists of initial stabilization by external fixation (in order to antagonise all the nociceptive and haemorrhagic stimuli from the fracture site if not fixed) followed by internal fixation when the patient becomes stable.(10,11)

Opponents of this method cited more frequent local complications (due to initial external fixation) and prolonged hospital stay as reasons to perform ETC, but decreased incidence of general complications - MSOF and death, as well as controversial data regarding local septic complications strongly recommended Damage Control as a valuable alternative in unstable and borderline patients.(11,12)

The study presented in third paper confirms the data from the literature and, in the same time, present valuable data from a trauma team who introduced the routinely evaluation of polytrauma as well as treatment algorithm according to the European Guides, in which ETC and DCOS have each of them, different indications.

One important aspect which is underlined by this study is that, within the study group, DCOS allowed the severely injured patients, with AIS of 4 or 5 for the thoracic, brain and abdominal injury, to survive, despite the initial most severe injuries. Due to the fact that the "second hit" phenomenon was thus avoided, not only that these patients survived, but they also sustained the following steps of the treatment and were nailed with positive outcome.

It is to be underlined that unfortunately, some patients from the study group arrived in our hospital late, thus limiting the therapeutic options, because in some cases, the initial injury worsened; although these were exceptions, they still have to be discussed as avoidable situations, as early treatment in polytrauma is one of the most important conditions for success.

Proper evaluation and treatment in polytrauma patients request a multidisciplinary trained team able to establish a common language and to implement the same valid algorithm; when these conditions are fulfilled, as presented in this study, the rate of mortality and complications is low, despite the severe initial impact of polytrauma.

CONCLUSIONS

Polytrauma treatment must rely on proper knowledge of its pathophysiology, which is mainly dependent on inflammatory response, so forbidding any circumstance which might enhance it, thus re-inducing SIRS. This so-called "second hit" phenomenon might avoid part of early mortality and most of the late mortality in polytrauma, thus significantly improving the outcome of the patients.

In borderline and unstable patients, early stabilization of the femoral fractures has unanimously been recognized as having a major positive impact upon the patient, but the method stabilization has been recently changed from ETC to DCOS, as to minimize the impact of surgery upon the patient.

The data present by the authors, reflecting our experience in applying modern principles in polytrauma treatment, are concordant with those from the literature and reflect the effectiveness of the coordinated intervention performed by a multidisciplinary trained team in severely injured patients.

REFERENCES

1. Keel M, Trentz O. Pathophysiology of polytrauma. *Injury*. 2005;36:691-709.
2. Chawda MN, Hildebrand F, Pape HC, Giannoudis PV. Predicting outcome after multiple trauma: which scoring system? *Injury*. 2004;35(4):347-58.
3. Giannoudis PV, Hildebrand F, Pape HC. Inflammatory serum markers in patients with multiple trauma. *J Bone Joint Surg (Br)*. 2004;86-B:313-23.
4. Scalea TM, Boswell SA, Scott JD, Mitchell KA, Kramer ME, Pollak AN: External fixation as a bridge to intramedullary nailing for patients with multiple injuries and with femur fractures: Damage control orthopedics. *J Trauma*. 2000;48:613-621.
5. Pape HC, Giannoudis PV, Krettek C, Trentz O. Timing of fixation of major fractures in blunt polytrauma: Role of conventional indicators in clinical decision making. *J Orthop Trauma*. 2005;19:551-562.
6. Pape HC, Hildebrand F, Pertschy S, Zelle B, Garapati R, Grimme K, et al. Changes in the management of femoral shaft fractures in polytrauma patients: from early total care to damage control orthopedic surgery. *J Trauma*. 2002;53:452-61.
7. Pape HC, Auf'm Kolk M, Paffrath T, Regel G, Sturm JA, Tscherne H. Primary intramedullary femur fixation in multiple trauma patients with associated lung contusion: a cause of post-traumatic ARDS? *J Trauma*. 1993;34:540-8.
8. Pape HC, Grimme K, Van Griensven M, et al. Impact of intramedullary instrumentation versus damage control for femoral fractures on immunoinflammatory parameters: prospective randomized analysis by the EPOFF Study Group. *J Trauma*. 2003;55:7-13.
9. Pape HC, Tscherne H. Early definitive fracture fixation, pulmonary function and systemic effects. In: Baue AE, Faist E, Fry M, editors. *Multiple organ failure*. New York: Springer; 2000. p.279-90.
10. Pape H-C, Regel G, Dwenger A: Influences of different methods of intramedullary femoral nailing on lung function in patients in multiple trauma. *J Trauma*. 1993;35:705-709.
11. Hildebrand F, Giannoudis P, Krettek C, Pape HC. Damage control: extremities. *Injury*. 2004;35:678-89.
12. Giannoudis P, Veysi VT, Pape HC, et al. When should we operate on major fractures in patients with severe head injuries? *Am J Surg*. 2002;183:261-267.