DAMAGE CONTROL IN TRAUMA & ORTHOPEDIC SURGERY

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פגיעת רב החומית
FIRST HIT

- the initial trauma

SECOND HIT

- major surgery
- adverse event during ICU treatment
- septic stimulus
TYPES OF INJURIES  (n = 2,069 Pts)

- **Head Injuries** 39.2%
- **Chest Injuries** 44.5%
- **Abdominal Trauma** 18.9%
- **Extermitis** 42/1%

*DGU Trauma Registry 1993-1997  (n = 2,069)*
Historical perspective

• “Definitive reduction of fractures in patients who have other injuries and who may have been in shock should be delayed until the general condition of the patient is satisfactory.”

• When was this phrase published?

  » “The care of fractures in the patient with multiple injuries”
Before the 1950s

The multi-trauma patient - “Too sick for an operation”

- the surgical stabilization of the fractures of the long bones was not routinely performed.
- The multiply-injured patient was not considered to be stable enough to withstand a prolonged surgical procedure.
- Cast and skeletal traction treatment preferred.
• 1950-1970s

There were reports that fracture healing would be quicker if the operation is delayed until up to 14 days after the injury.
• **1970s**

Pioneering studies showed that **early stabilization of femoral fractures reduced dramatically incidence of Fat Emb. Syndrome (ARDS)** and postoperative complications.
Conclusions of Late 1980s

“There is a beneficial effect of early stabilization of fractures on both mortality and morbidity and length of hospital stay.”

This new philosophy in the management of the patient with multiple injuries was named Early Total Care (ETC).

“The patient is too sick not to be treated surgically”
Early total care (ETC).

Optimum treatment in surgery for trauma and developments in ICU supported this more aggressive approach to the injured patients.

Patients were able to mobilize early and were discharged from hospital sooner, avoiding the complications associated with prolonged bed rest.

Best operation for a patient is one, early and definitive procedure!
Early 1990s

Outcome after ETC – increased incidence of adult respiratory distress syndrome ARDS and multiple organ failure (M.O.F)

These complications mainly developed in patients with severe chest injuries, severe hemodynamic shock and in cases post reamed intramedullary nailing without thoracic trauma.
IS E.T.C IS REALY SAFE ???

Patients with high ISS had high mortality rate even when treated early (Pape J Trauma 1995 - 3406 polytrauma Pts).
1990s - Damage Control Orthopaedics

An approach that contains and stabilizes orthopaedic injuries, so that the patient's overall physiology can improve.

Its purpose is to avoid worsening of the patient's condition by the "second hit" of a major orthopaedic procedures.
DAMAGE CONTROL ORTHOPAEDICS: EVOLVING CONCEPTS IN THE TREATMENT OF PATIENTS WHO HAVE SUSTAINED ORTHOPAEDIC TRAUMA

Roberts, Pape, Jones, Malkani, Rodriguez, Giannoudis

In severely injured patients, invasive fracture fixation surgery

Stimulates a secondary inflammatory reaction (SIRS)

“The second hit” detectable by an elevation of pro-inflammatory cytokines

J Trauma 2001;50:989-100
J Trauma 2002;53:452-61
J Trauma 2003;55:7-13
Unfallchirurg 2003;106:87-96
In severe multiple-injured patient

- The cytokine response evidenced by fever, leukocytosis, hyperventilation, and tachycardia commonly seen in injury is referred to as Systemic Inflammatory Response Syndrome (SIRS)

- This inflammatory reaction has been implicated in the development of ARDS and Multi-Organ Failure (MOF)

Physiology of Damage Control Orthopaedics

Traumatic injury induces a systemic inflammatory response - SIRS.

Severe SIRS – acute organ failure & early death

After trauma, there is a balance between the systemic inflammatory response (SIRS) and the contraregulatory anti-inflammatory response (CARS).
The “two hits” theory

**FIRST HIT**

- Severe response

**SIRS REACTION**

- Nature ??

- Surgical procedures

**SECOND HIT**

**RESOLUTION**
History of fracture care in polytrauma

- No routine initial stabilization
- "too sick to operate on"
- Early Total Care (ETC)
- "too sick not to operate on"
- ETC not appropriate for all
- "the OR is the safest place"
- "patient at risk"
- "Damage Control Orthopedics"

Planning and optimal timing of fracture stabilization is essential in the treatment of polytraumatized patients.

Any mistakes will lead to difficult consequences regarding the morbidity and may increase the mortality rate.
MATERIAL AND METHODS

Our Experience

From 1995 to 2007 there were 128 polytraumatized patients with femoral shaft fracture treated in our hospital. The outcomes of their treatment were retrospectively analyzed in this study.
Patients were grouped according the treatment strategies for stabilization of the femoral shaft fracture:

- GROUP A – 99 patients treated with early total care (ETC) - intramedullary nailing (IMN) within 24 h of injury

- GROUP B – 27 patients treated with temporary external fixation as a bridge to IMN - DCO surgery
GROUP B - DCO
CLINICAL EXAMPLE 1

35 Y MALE RTA

# BOTH FEMURS + RT TIBIA
# FOREARM + FOOT
1ST Day:  EXT FIX BOTH FEMUR+RT TIBIA
2nd Day: post EXT FIX BOTH FEMUR+RT TIBIA
6th Day: conversion of EXT FIX tp IMN
DAMAGE CONTROL ORTHOPAEDICS

CLINICAL EXAMPLE 2

22 Y MALE  RTA

# BOTH TIBIA  + LT TIBIA

DISLOCATION RT KNEE

TEAR POPLITEAL ARTERY RT
Example 1

D.C.O CL INICAL EXAMPLE 2: 22 Y Male RTA;

**Rt leg** – deformation of knee and upper shin
- POP DP TP pulses not felt-cold extremity
- degloving injury dorsum of foot
- closed fracture G IIIA tibia

**Lt leg** - open fracture G IIIA thigh
- open fracture G IIIA tibia
- neurovascular status normal

**Pelvis** - Fracture of f acetabulum Lt

**CT angio**
No flow of contrast substance distal to Hunter canal-
susp tear popliteal artery
Tx in OR

Temporary interposition graft to POP artery Rt

Debridement of wounds

Bridging Ext Eix femur-tibia Rt
Rt Saphenous interposition graft to POP artery

Closed reduction Ext Fix fractures Lt femur and tibia
Follow up post op

Patient admitted to ICU
Pulmonary contusion signs

Five days later
Signs of gangrene
Rt foot and calf

Back to OR

Amputation above knee
Rt
One week later-

**definitive treatment**

**Exchange Ext Fix Lt femur**
**BY Closed IMN Lt femur**
One week later-

definitive treatment

**Exchange Ext Fix Lt tibia**

**Closed IMN Lt tibia**
RESULTS

- There was significantly higher incidence of ARDS in group A
  18.2% vs 8.6% in group B

- The incidence of MOF was significantly lower in DCO group –
  7.4% than in ETC group - 12.1%

- There were 3 unexpected deaths and 2 cases with worsening in patients with head injury in group A
RESULTS

There were no significant differences in the incidence of local complications:

- infections
- delayed unions
- nonunions
RESULTS

- A significant reduction in the incidence of general systemic complications (ARDS, MOF) was found in group B (DCO) in comparison with group A (ETC).

- Changing of the treatment protocol from ETC to DCO is not associated with increased rate of local complications.

- Lower complication rate in DCO despite higher ISS appears to be an viable alternative for polytrauma patients with femoral shaft fracture at risk.
DISCUSSION
Damage control

“damage control”
was originally coined by US Navy
to describe tactical approaches to
permit a damaged sea vessel in naval battle
to continue functioning.
Reamed Intramedullary nailing

Has been associated with development of “second hit” phenomena (Pape 1993).

Primary external fixation has not stimulated any inflammatory reaction (“second hit”)

EXTERNAL FIXATION

is a safe, viable procedure to achieve temporary rigid stabilization in patient with multiple injuries, at risk of adverse outcome.
**Damage control in orthopedic surgery**

**MINIMALLY INVASIVE OPERATIONS:**

**External fixation of femur-**
35 minutes
90 ml blood loss

**Intramedullary nailing of femur-**
130 minutes
400 ml blood loss

Damage control in orthopedic surgery

Stage 1: early temporary External Fixation Stabilization of unstable fractures and the control of hemorrhage and, if indicated, decompression of intracranial lesion.

Stage 2: resuscitation of the patient in ICU and optimization of his condition.

Stage 3: delayed definitive management of the fracture
Damage control in orthopedic surgery

**SIMILARE FINDINGS - PAPE 2001**

Two groups of patients with a similar injury severity score and GCS:

- **EARLY** (2-4 days)
- **DEFINITIVE TREATMENT**
- **LATE** (5-8 days)

46% Multiple organ dysfunction 15.7%

Pape HC et al., J.Trauma 2001:50: 989-1000
RESUSCITATION:
• Stable hemodynamics
• Stable oxygen saturation
• Lactat level < 2 mmol/l
• No coagulation disturbances
• Normal temperature
• Urinary output > 1 ml/kg/hour
• No isotropic support
Summary

• There is evidence that initial stabilization of long bone fractures is beneficial

• There is no evidence that early / late definitive fixation of long bone fractures has any beneficial / detrimental effect on survival

• Debate remains on which prognostic factors influence decision making for “risk adaption” including brain and thoracic injury

• Plan definitive osteosynthesis early (day 5-10)
### EARLY TOTAL CARE (ETC) VS DAMAGE CONTROL (DCO)

<table>
<thead>
<tr>
<th>Physiological Status</th>
<th>Surgical Intervention</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Response to resuscitation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>Life saving surgery</td>
<td><strong>DAY 1</strong></td>
</tr>
<tr>
<td>?</td>
<td>“Damage Control”</td>
<td></td>
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<tr>
<td>+</td>
<td>Early total care</td>
<td></td>
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<tr>
<td><strong>Hyper-inflammation</strong></td>
<td></td>
<td><strong>DAYS</strong> 2-3</td>
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<tr>
<td></td>
<td>“second look” only</td>
<td></td>
</tr>
<tr>
<td><strong>“Window of opportunity”</strong></td>
<td>Scheduled definitive surgery</td>
<td><strong>DAYS</strong> 5-10</td>
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<tr>
<td><strong>Immunosuppression</strong></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>NO surgery</td>
<td></td>
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<tr>
<td><strong>Recovery</strong></td>
<td>Sec. reconstructive surgery</td>
<td><strong>WEEK 3</strong></td>
</tr>
</tbody>
</table>
THE “KILLERS”

- Exsanguinating hemorrhage
- Tentorial herniation
- Hypoxia
- Sepsis
EARLY TOTAL CARE

CLINICAL CASES
Tension pneumothorax

- Pathophysiology

  "One-way-valve" air leak

  Decreased venous return

  Displaced mediastinum to opposite side
Early Total Care

- Reduction of dislocation
Early Total Care
SPINAL FRACTURES
SPINAL FRACTURES
Early Total Care

TEAR OF POPLITEAL ARTERY AFTER KNEE DISLOCATION
Early Total Care

TEAR OF POPLITEAL ARTERY
Early Total Care

Repair of Popliteal Artery
Early Total Care

Compartment syndrome
Early Total Care

• DEBRIDEMENT AND IRRIGATION OF OPEN FRACTURES
Damage control in orthopedic surgery

LONDON BRACE

simple temporary stabilizator of pelvic
THE ANTISHOCK PELVIC CLAMP

Thank you