THE MANGLED EXTREMITY

TO SALVAGE OR SEVERE: Myths and Misconceptions

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MYTH #1

Dr. Knudson knows how to mangle!!!
DEFINITION OF MANGLED EXTREMITY

- **Def. #1:** a combination of injuries to arteries, bone, tendons, nerves and soft tissue
- **Def. #2:** a mangled extremity is one in which **amputation** is a potential outcome

**Current Problems in Surgery, Nov. 2009**
MYTH #2

Tourniquets are an instrument of the devil and should never be applied!
Prehospital Tourniquet Use Life-Saving in Military Casualties

- Should be applied close to the wound
- Use a **CAT** tourniquet (not makeshift)
- Should be tightened until **pulse disappears**
- Consider a second tourniquet for bleeding
- Should be applied to the skin directly
- **Record time of application**
- Remove within 2 hours???

Krugh et al, Ann Surg 2009
Myth #3: Care algorithms are helpful and should always be followed.
Don’t be distracted by the obvious!

- Remember your ABCs of trauma care
- High index of suspicion for other injuries
- Save the patient first, the limb second
MYTH #4: WHAT YOU SEE IS WHAT YOU GOT
MOREL-LAVALLEE

- Closed, internal degloving injury
- Traumatic separation of the skin and subQ from the underlying fascia
- Results from shearing force/crush injury
- Large lesions: skin necrosis

Nickerson J Trauma ACS 2014
MYTH #5: SCORING SYSTEMS ARE HELPFUL IN PREDICTING OUTCOME

• Entire alphabet soup of scoring systems
• Developed to predict the need for amputation
• Primarily applied to lower extremity fractures
# Mangled Extremity Scoring Systems

<table>
<thead>
<tr>
<th>Score</th>
<th>bone</th>
<th>tissue</th>
<th>nerve</th>
<th>Vasc.</th>
<th>shock</th>
<th>time</th>
<th>age</th>
<th>Co-mb</th>
<th>Cont.</th>
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<tbody>
<tr>
<td>MESSi</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
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<tr>
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<td>Y</td>
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<td>N</td>
<td>Y</td>
<td>N</td>
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</table>
Summary of Scoring Systems

- Low scores are predictive of salvage
- **But HIGH scores do not necessarily correlate with the need for amputation**
- All scores need updating in this age of advanced soft tissue coverage, free flaps, antibiotic beads, nerve transfers and vascular techniques
One Score to Know

Modified **Gustilo-Andersen** Class for Open Fxs:

**I**: a fx with a clean laceration < 1cm; low velocity

**II**: a fx with a lac > 1cm

**III**: a fx with soft tissue loss:

  **IIIA**: adequate coverage

  **IIIB**: periosteal striping; flap required

  **IIIC**: open fracture plus arterial injury
A Pragmatic Approach to Limb Salvage

- Consider the time/delay
- **Blunt** worse than penetrating
- Lower ext. worse than upper
- Age/physiologic health
- **Clinical presentation/shock**
- Associated injuries
- Environment: combat/austere/mass casualties

*Pasquale et al ACS/COT 2006*
Myth #6: Nothing good every comes from Orthopods
Along Came LEAP

- Lower Extremity Assessment Project (LEAP)
- Multi-center, prospective observational study
- Funded by NIH
- Co-PIs: Ellen MacKenzie, Michael Bosse
- Focus: Decision to amputate or salvage severely injured lower extremities
Inclusion Criteria for LEAP study

• Traumatic amputations below femur
• Gustilo IIA with nerve, bone, muscle injury
• Gustilo IIIB/IIIC open tibia fractures
• **Vascular injuries** below the femur
• Major soft tissue injuries below the femur
• Grade III open pilon fractures
• Grade IIIIB open ankle fractures
• Open hindfoot/midfoot with degloving/nerve
LEAP STUDY and MYTH #5

• 556 patient from 8 major trauma centers
• Prospectively evaluated 5 different mangled extremity scoring systems
• NONE were useful in predicting the need for amputation
• No evidence-based alternative was proposed

• Bosse JBJS 2001
Myth #7: Plantar Sensation

- Lack of plantar sensation at the initial presentation demands an amputation
LEAP TO THE RESCUE!

- 26 insensate plantar feet that were amputated
- 29 insensate feet that were salvaged
- 29 matched controls
- 2-year follow-up: most plantar sensation was restored
- Lack of initial plantar sensation was not an indication for amputation nor did it predict long-term functional outcome
Myth #8: A single tibial vessel run-off is sufficient in the mangled extremity
Limb Salvage and Tibial Vessels

- AAST Poster Presentation 2014
- 84 Patients: limited/no flow in AT, PT peroneal arteries; **observed initially**
- # of open vessels=limb salvage
- Limb salvage group: **2.7** open vessels
- Amputation group: **1.1** open vessels (p<0.05)

- *Dua, Dubose, Holcomb UT Houston*
Myth #9: A SALVAGED LIMB IS ALWAYS BETTER THAN AN AMPUTATION
• Sub-set of Myth #9: Orthopedic surgeons will never be caught reading the NEJM!!

Past medical history of heart stuff and blah, blah, blah. Plan OR tonight.
—An orthopedic surgeon's H&P

someecards.com
LEAP Study and Functional Outcomes

- 601 patients from 8 trauma centers
- Main Outcome variable: **Sickness Impact Profile (SIP)**
- Self-reported health status, 136 statements
- At 2 years, no significant difference in SIP scores between amputees and salvaged limbs

- *Bosse, Mackenzie NEJM 2002*
Limb Salvage Lesson 101

- Limb salvage is not always safe!
Limb salvage is not always safe

Limb salvage attempted despite concern by attending trauma surgeon.....
ICU Code

• Bleeding out from severe venous hypertension

• Required emergency guillotine amputation!
Myth #10: Limb salvage is more expensive than amputations

- Costs included initial and subsequent hospitalizations, in and outpatient rehab, physician visits, and prosthetics
- Life-time projected costs were 3 times higher for the amputation group ($509k vs. $163k)

*Leap Investigators JBS 2007*
FINAL THOUGHTS ON AMPUTATION VERSUS SALVAGE

“Absolute” indications for amputation:

- Complete or near-complete amputation
- Irreparable vascular injuries
- Large soft-tissue defect with bone and nerve loss that will not allow a functional recovery
- Warm ischemia time > 8 hours
- Cadaveric foot
- 2-surgeon agreement (©3)
Final Thoughts: Amputate or Save?

**Relative** indications for amputation:

- Gustilo Grade IIIC (extensive tissue loss and vascular injury)
- Failed vascular graft with ongoing ischemia
- Infected limb with clostridia/necrotizing
- A patient in extremis
- **Multiple casualties**
The Mangled Extremity Score: Time for a Revision

- AAST-Prospective Vascular Injury Registry
- Demographic, diagnostic, treatment and outcome data-14 U.S. Level 1 trauma centers
- 230 pts: lower extremity arterial injuries
- 9.1%: immediate amputation
- MESS ≥ 8: more transfusions, ICS LOS
- Only predicted amputation in 32.7%
# FAILURE OF OLD MESS SCORE

<table>
<thead>
<tr>
<th>MESS Elements</th>
<th>Amputations (mean score) n=42</th>
<th>Not Amputated n=137</th>
<th>P-value unadjusted</th>
<th>P-value adjusted*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skeletal/soft tissue score</td>
<td>2.58</td>
<td>1.71</td>
<td>&lt;0.0001</td>
<td>0.54389</td>
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<tr>
<td>Limb ischemia</td>
<td>1.93</td>
<td>1.16</td>
<td>&lt;0.0001</td>
<td>0.5560</td>
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<tr>
<td>shock</td>
<td>0.51</td>
<td>0.32</td>
<td>0.20</td>
<td>0.5150</td>
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<tr>
<td>Age score</td>
<td>0.86</td>
<td>0.66</td>
<td>0.22</td>
<td>0.2272</td>
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<tr>
<td>Total MESS</td>
<td>6.58</td>
<td>4.29</td>
<td>&lt;0.0001</td>
<td>0.2643</td>
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</tbody>
</table>

*Adjusted for significant confounders including mechanism, arterial transection, concomitant nerve and orthopedic injuries*
Final Myth

You would love to listen to Dr. Knudson lecture on this subject for several more hours rather than watch video......