Complex hand injuries & complications

Open fractures

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Open # are challenging because

- soft-tissue damage
- wound contamination
- loss of skeletal stability
And are usually combined with

- fracture comminution
- periosteal stripping
- bone loss
- injury to vessels, nerves, and tendons
Principles of management

adequate irrigation and debridement

soft-tissue coverage

acceptable reduction & stabilization

antibiotic therapy

late reconstruction
Epidemiology

1992-2005, 8,946 hand injuries
amputations (32.3%),
fractures (23.7%),
open wounds (19.9%)
76.3% injured during paid work
while operating a machine
Epidemiology

Hand injuries constitute for both countries 29% of all unintentional injuries.
Mechanism of injury

The degree of soft-tissue injury and bone comminution are determined by the impact energy and the mode of application.

A detailed history will alert the surgeon to the nature and degree of contamination:
- farm
- industrial
- meat packing plant
- chemicals
- overlying gloves e.t.c.
## Mechanism of injury

### Causes and consequences of hand injuries

Marek Trybus, M.D., Ph.D.,* Jacek Lorkowski, M.D., Ph.D., Leszek Brongel, M.D., Ph.D., Waldemar Hładki, M.D., Ph.D.

<table>
<thead>
<tr>
<th>Level of trauma</th>
<th>Machine (%)</th>
<th>Cut (%)</th>
<th>Fall (%)</th>
<th>Crush (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level I</td>
<td>11.61</td>
<td>28.02</td>
<td>13.67</td>
<td>10.49</td>
</tr>
<tr>
<td>Level II</td>
<td>45.4</td>
<td>30.08</td>
<td>5.02</td>
<td>8.64</td>
</tr>
<tr>
<td>Level III</td>
<td>56.4</td>
<td>38.39</td>
<td>0.94</td>
<td>1.9</td>
</tr>
<tr>
<td>Level IV</td>
<td>88.42</td>
<td>4.22</td>
<td>2.11</td>
<td>3.16</td>
</tr>
</tbody>
</table>
## Classification

### Table I. Open Fracture Wound Classification (Modified Gustilo-Anderson)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>Tidy laceration, &lt;1 cm in length; no contamination, soft-tissue crush, loss, or fracture comminution</td>
</tr>
<tr>
<td>Type II</td>
<td>Tidy laceration, &lt;2 cm in length; no contamination, soft-tissue crush, loss, or fracture comminution</td>
</tr>
<tr>
<td>Type III</td>
<td>Laceration, &gt;2 cm; penetrating or puncturing projectile wound, soft-tissue crush, blast injury, periosteal stripping, or wound contamination</td>
</tr>
</tbody>
</table>

![Grade I](image1.png)

Grade I

![Grade II](image2.png)

Grade II

![Grade III](image3.png)

Grade III
Classification

<table>
<thead>
<tr>
<th>Type</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&lt;1 cm</td>
<td>Clean wound without contamination, soft-tissue crush, or fracture comminution</td>
</tr>
<tr>
<td>2</td>
<td>&gt;1 cm</td>
<td>Clean wound with no periosteal stripping, soft-tissue envelope intact, no fracture comminution</td>
</tr>
<tr>
<td>3</td>
<td>&gt;1 cm</td>
<td>Contaminated wound, fracture with significant comminution and periosteal stripping, soft-tissue crush injury, farm injuries, blast injuries</td>
</tr>
</tbody>
</table>

Reprinted from McLain et al\textsuperscript{34} with permission from “The American Society for Surgery of the Hand”. 
Classification of Open Fractures of the Hand

Robert F. McLain and Curtis M. Steyers

146 fractures

11% Type I
29% Type II
60% Type III

Overall incidence of infection 11%
- 0% in Type I
- 9% in Type II
- 14% in Type III

- Infection occurred in 20.5% of patients with contaminated wounds
- 87% of infections occurred in crush or untidy laceration injury patterns
Open hand fractures: Prognosis and classification

Todd V. Swanson, MD, Robert M. Szabo, MD, Daniel D. Anderson, MD

Classification

**Type I:** Clean wound and no systemic illness

**Type II:** Contaminated wound, delay in treatment > 24 h hours, or significant systemic illness
Type I and II open fractures were managed in the ED with irrigation, debridement, fracture stabilization and soft tissue coverage

Later (within 24h) in the OR: unstable fractures, fractures with malalignment, wounds that required skin graft, neurovascular injuries, and severe tendon injuries

Directly to OR: vascular compromise or severe mangling open wounds

Only 2/145 infections (1.4%)
# Studies That Have Reported Infection Rate After Open Hand Fractures

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>Patients/Injuries</th>
<th>Infection Rate</th>
</tr>
</thead>
</table>
| 1987 | Sloan et al⁰ | 85 distal interphalangeal joint fractures  
- 10 cases, antibiotics not administered  
- 73 cases, antibiotics administered | — Antibiotics, 1.3%  
(1/73)  
— No antibiotics, 0.3%  
(3/10) |
| 1990 | Suprock et al¹⁰ | 91 phalanx fractures  
— 46 cases, antibiotics not administered  
— 45 cases, antibiotics administered | — Antibiotics, 8.9%  
(4/45)  
— No antibiotics, 8.7%  
(4/46) |
| 1991 | McLain et al⁷ | 143 cases (146 hands)  
— Type I, 11%  
— Type II, 29%  
— Type III, 60% | 11% (16/143)  
— Type I, 0%  
— Type II, 9%  
— Type III, 14% |
| 1991 | Chow et al¹¹ | 201 patients  
— 245 open digital fractures | 2.04% |
| 1993 | Drenth & Klasen¹³ | 33 patients  
— 36 fractures (27 open) | 0% |
| 1996 | Ip et al¹⁴ | 765 patients  
— 994 fractures (342 open) | 7.7% (19/248) |
| 2001 | Van Oosterom et al¹⁶ | 350 cases  
— 666 fractures | 2% (8/490) |
| 2003 | Stevenson et al¹⁵ | 193 distal phalanx fractures | — Antibiotics, 3%  
— No antibiotics, 4% |
| 2007 | Ali et al¹⁷ | 120 patients  
— 226 fractures (68 open;  
Metacarpals & proximal &  
middle phalanges 56.7%,  
41 distal interphalangeal  
Joints 34%) | 2.2% (5/226) |

**Infection rate 0.3 – 11%, mean 4%**
Bacteriology

Staphylococcus & streptococcus are the most commonly infecting organisms

Especially wounds contaminated by:

soil (gram-negative and anaerobic bacteria)

warm river or lake water (Aeromonas hydrophila, P. aeruginosa, Vibrio vulnificus and Mycobacterium marinum)

saliva, (Eikenella corrodens and anaerobics)

Cat and dog bites are associated with Pasteurella multocida infection
Antibiotics

Significantly increased risk for infection when prophylactic antibiotics were not used after open fractures of the distal phalanx


Antibiotic prophylaxis is not necessary in open wounds of the hand, including open fractures, that undergo immediate aggressive debridement.

Antibiotics

Minimal contamination
- first-generation cephalosporins or semisynthetic penicillins
- vancomycin is used in the allergic patient

More contaminated wounds
aminoglycoside

Contamination by dirt or saliva (anaerobic infection)
Penicillin and Doxycycline

Activity against Clostridium species
vancomycin and fluoroquinolone.
Antibiotics

Prophylactic antibiotics should be used for no longer than 48 to 72 hours.

Postoperative prophylaxis of greater than 4 days has been associated with altered antimicrobial sensitivities of infecting organisms.

In the management of complex open hand trauma, there seems to be little benefit to extending antibiotic treatment beyond 5 days.
Fracture management

Rigid fixation of fractures promotes bony union and allows early mobilization.

Metallic hardware weakens local defenses and can allow bacterial adherence and glycocalyx formation.
Gustilo type I

Due to very low infection rate these fractures can be treated with adequate fixation as mandated by the fracture pattern.
Gustilo type II

Higher rate of infection and frequently are associated with an increased degree of bony comminution. Immediate irrigation and debridement and external or KW fixation followed by delayed primary wound closure and internal fixation 2 to 7 days after injury has good results.
- Worse results in open fractures

- Absolute indication in intra-articular fractures affecting both articular surfaces of the joint

- Good option in accompanying severe soft tissue damage
There was no statistically significant difference in infection and nonunion rates when comparing open and closed fractures.
Gustilo type III

More challenging problem. Because of the attendant risk for infection, fixation with an external fixator or K-wires until the soft tissue is stabilized and there is no evidence of infection. Skin graft or special designed flaps are usually necessary
Bone or soft tissue loss

Primary arthodesis in a functional position is a good option
Conclusions

Hand injuries are the main cause of work-related disability in young adults.

Open hand fractures are commonly combined with severe comminution, soft tissue damage, and wound contamination.

Aggressive debridement, antibiotic coverage, and appropriate timing of closure or soft-tissue coverage are essential for a good functional outcome.

For McLain type I and II injuries the fracture can be managed as a closed injury with KW, Ex-Fix or specially designed plates.
Conclusions

Treatment of a **McLain type III** open fractures must focus on the soft-tissue envelope, the vascularity of the injured part, and the inherent risk for infection.

Late reconstruction can be performed as soon as the soft tissues are viable and there are no signs of infection.
Mangled hand injuries