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

ACTA ORTHOPAEDICA et TRAUMATOLOGICA TURCICA

Acta Orthop Traumatol Turc 2010;44(5):352-360
doi:10.3944/AOTT.2010.2372

Epidemiology of injuries treated at a hand and microsurgery hospital

Aslı DAVAS AKSAN, Raika DURUSOY, Sait ADA,* Murat KAYALAR,* Feride AKSU, Emin BAL*

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

European Journal of Epidemiology **19**: 323–327, 2004.

INJURY EPIDEMIOLOGY

The epidemiology of hand injuries in the Netherlands and Denmark

Claus Falck Larsen[1], Saakje Mulder[2], Anne Mette Tranberg Johansen[3] & Christine Stam[2]

Hand injuries constitute for both countries 29% of all unintentional injuries

	Hand injuries		All injuries	
	Nl	Dk	Nl	Dk
Home and leisure accident (excl. sports accidents)	59	57	56	58
Occupational accident	18	23	11	16
Sports injury	15	15	18	16
Transport accident	7	5	14	10
Total	100	100	100	100

Table 3. Top-5 of hand injuries for the Netherlands and Denmark; percentages and incidence rates

	%	Rate per 100,000 inh.
The Netherlands		
1. Superficial injury to fingers	18	330
2. Open wound fingers	18	320
3. Wrist fracture	14	260
4. Superficial injury hand excl. fingers	10	180
5. Finger fracture	9	160
Denmark		
1. Open wound fingers	25	900
2. Superficial injury to fingers	14	510
3. Wrist fracture	12	440
4. Open wound hand excl. fingers	8	270
5. Finger fracture	7	250

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

Excerpta Medica

The American Journal of Surgery

The American Journal of Surgery 192 (2006) 52–57
Clinical surgery–International

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.

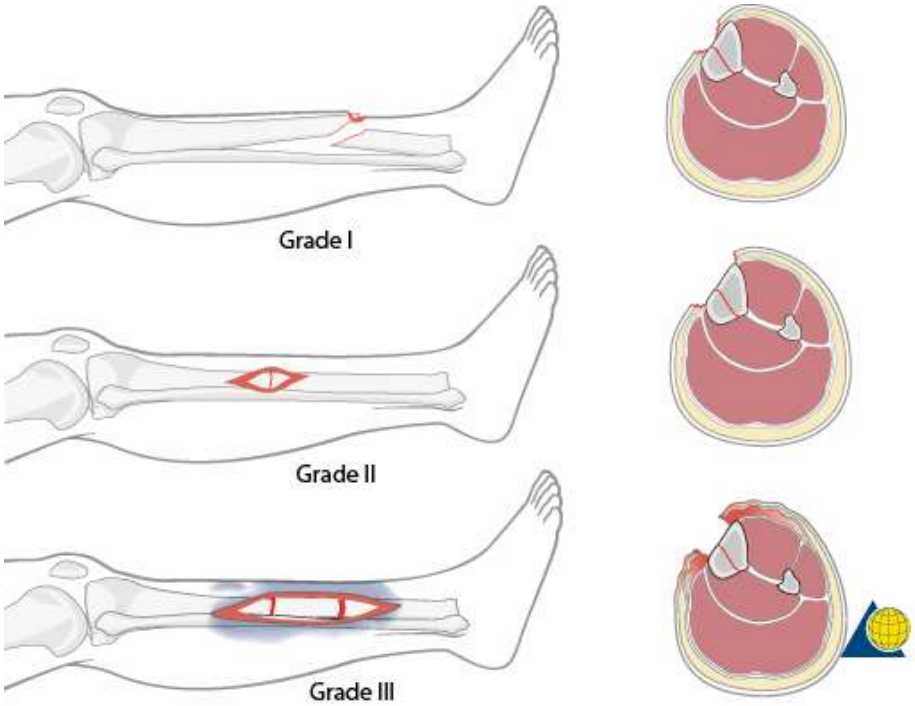
Causes of hand trauma

Level of trauma	Machine (%)	Cut (%)	Fall (%)	Crush (%)
Level I	11.61	28.02	13.67	10.49
Level II	45.4	30.08	5.02	8.64
Level III	56.4	38.39	0.94	1.9
Level IV	88.42	4.22	2.11	3.16

Classification

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

Type I	Tidy laceration, <1 cm in length; no contamination, soft-tissue crush, loss, or fracture comminution
Type II	Tidy laceration, <2 cm in length; no contamination, soft-tissue crush, loss, or fracture comminution
Type III	Laceration, >2 cm; penetrating or puncturing projectile wound, soft-tissue crush, blast injury, periosteal stripping, or wound contamination



Classification

The McLain et al[34] Modified Gustilo Classification for Open Hand Fractures

Type	Size	Description
1	<1 cm	Clean wound without contamination, soft-tissue crush, or fracture comminution
2	>1 cm	Clean wound with no periosteal stripping, soft-tissue envelope intact, no fracture comminution
3	>1 cm	Contaminated wound, fracture with significant comminution and periosteal stripping, soft-tissue crush injury, farm injuries, blast injuries

Reprinted from McLain et al[34] with permission from "The American Society for Surgery of the Hand".

The IOWA ORTHOPAEDIC JOURNAL

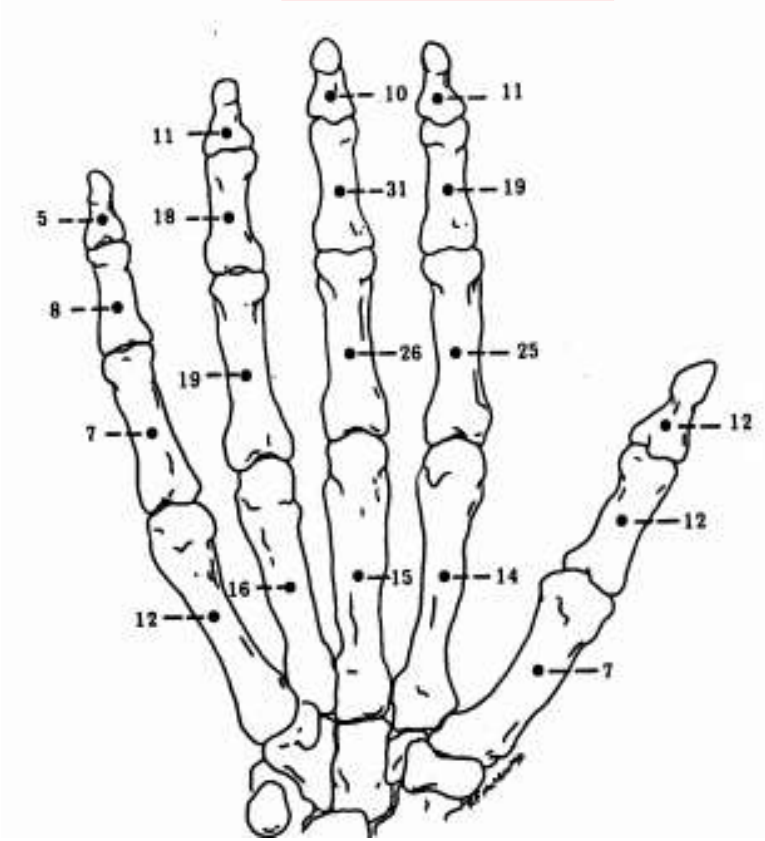
Iowa Orthop J. 1991; 11: 107–111.

PMCID: PMC2328973

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

The Journal of Hand Surgery
Volume 16, Issue 1, January 1991, Pages 101–107

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

An Original Study

Am J Orthop. 2011;40(12):E243-E248.

Initial Management of Open Hand Fractures in an Emergency Department

John T. Capo, MD, Michael Hall, BS, Ali Nourbakhsh, MD, Virak Tan, MD, and Patrick Henry, MD

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%)

Table V. Distribution of Metacarpal and Phalanx Fractures

Fracture Type	No.
Metacarpus Fracture	
1st metacarpus	6
2nd metacarpus	6
3rd metacarpus	6
4th metacarpus	9
5th metacarpus	9
Total	**36**
Phalanx Fracture	**No.**
Thumb	21
Index finger	30
Middle finger	40
Ring finger	26
Small finger	21
Total	**138**

Table III. Mechanisms of Injury in Our Patient Cohort

Mechanism	No.	%
Work related	54	37%
Crush injury	36	25%
Gunshot	21	14%
Assault	10	7%
Fall	7	5%
Cut	6	4%
Other (motor vehicle accident, bite, etc)	11	8%
Total	145	

Studies That Have Reported Infection Rate After Open Hand Fractures

Year	Author	Patients/Injuries	Infection Rate
1987	Sloan et al[9]	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 al[10]	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 al[7]	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 al[11]	201 patients —245 open digital frac-	2.04%
1993	Du		
1996	Ip et al[14]	765 patients —924 fractures (342 open)	7.7% (19/248)
1998	Drenth & Klasen[13]	33 patients —36 fractures (27 open)	0%
2001	Van Oosterom et al[16]	350 cases —666 fractures	2% (8/490)
2003	Stevenson et al[15]	193 distal phalanx fractures	—Antibiotics, 3% —No antibiotics, 4%
2007	Ali et al[17]	120 patients —226 fractures (68 open; Metacarpels & 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

Sloan JP, Dove AF, Maheson M, et al. Antibiotics in open fractures of the distal phalanx. J Hand Surg 1987;12B:123-124.

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

Peacock KC, et al. Efficacy of perioperative cefamandole with post operative cephalexin in the primary outpatient treatment of open wounds of the hand. J Hand Surg 1988; 13A:960-964.

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 flouroquinolone.

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.

SCIENTIFIC ARTICLE

Use of a Mini-External Fixator for the Treatment of Hand Fractures

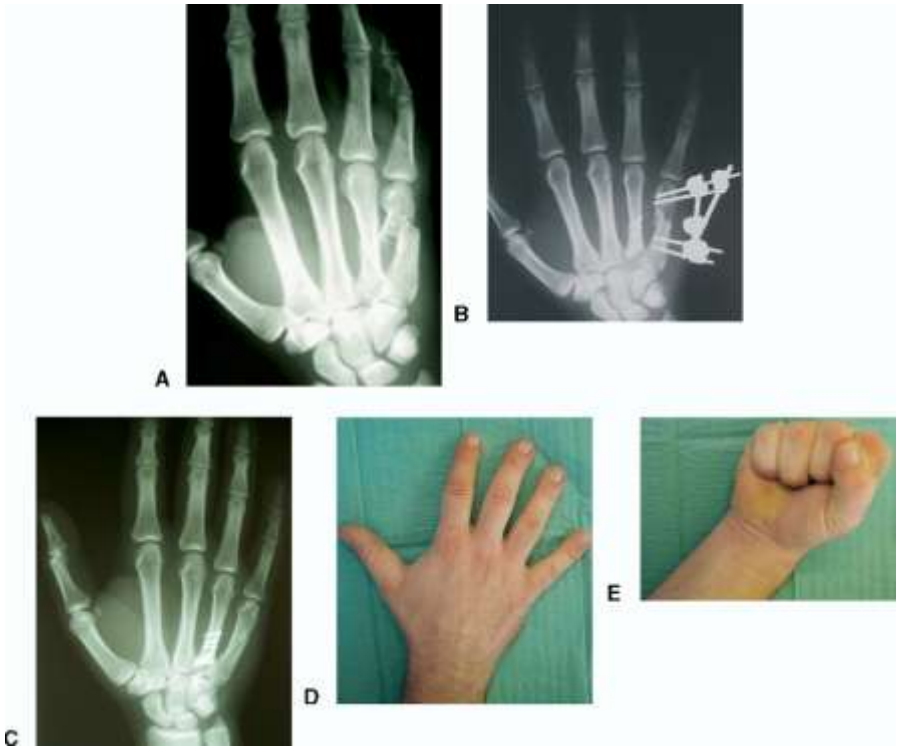
(J Hand Surg 2009;34A:630–636.

Z. Dailiana, MD, D. Agorastakis, MD, S. Varitimidis, MD, K. Bargiotas, MD, N. Roidis, MD, K. N. Malizos, MD

- 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

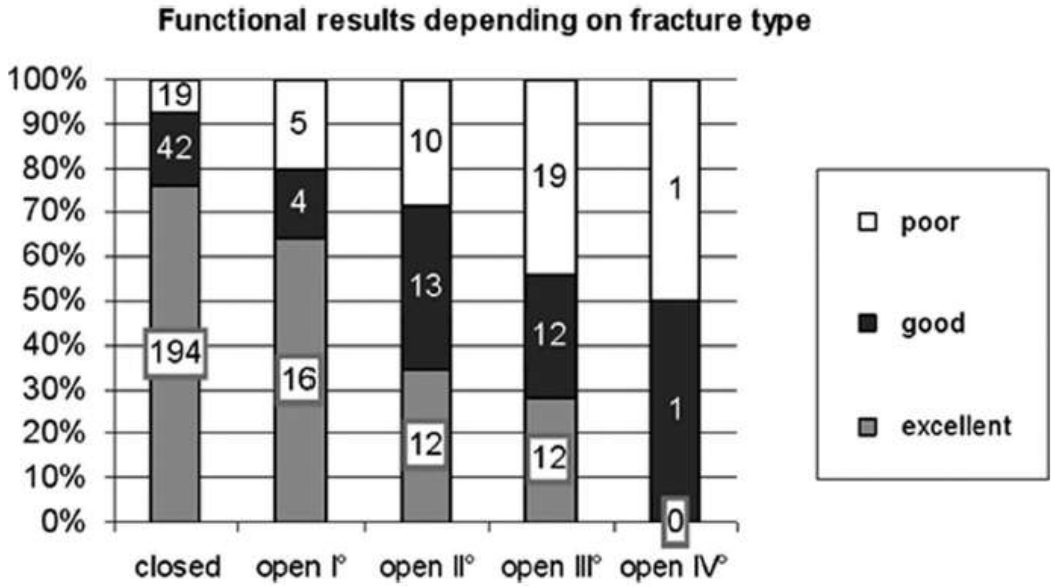


Ten Years Stable Internal Fixation of Metacarpal and Phalangeal Hand Fractures—Risk Factor and Outcome Analysis Show No Increase of Complications in the Treatment of Open Compared With Closed Fractures

Holger Bannasch, MD, Anne K. Heermann, MD, Niklas Iblher, MD, Arash Momeni, MD, Jürgen Schulte-Mönting, Dr. rer. nat, and G. Bjoern Stark, MD

(*J Trauma.* 2010;68: 624–628)

There was no statistically significant difference in **infection** and **nonunion rates** when comparing open and closed fractures.

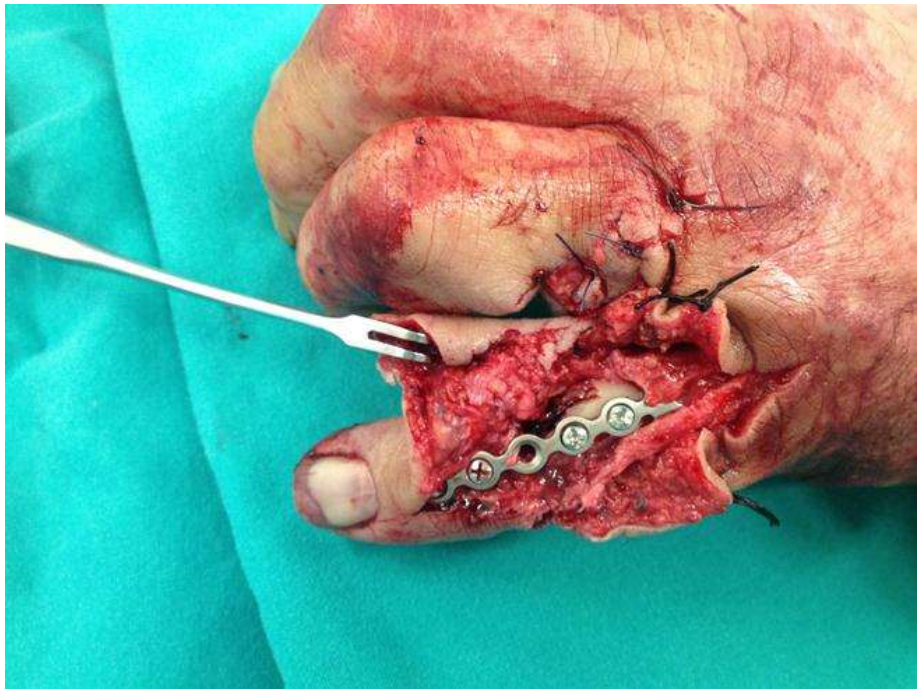


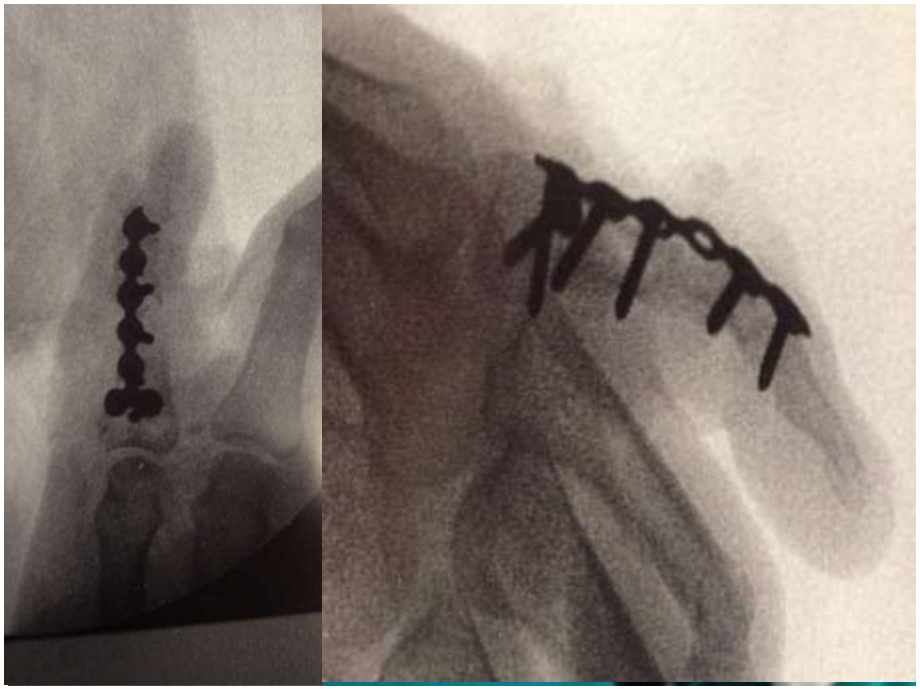
Gustilo type III

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 no signs of infection

Mangled hand injuries