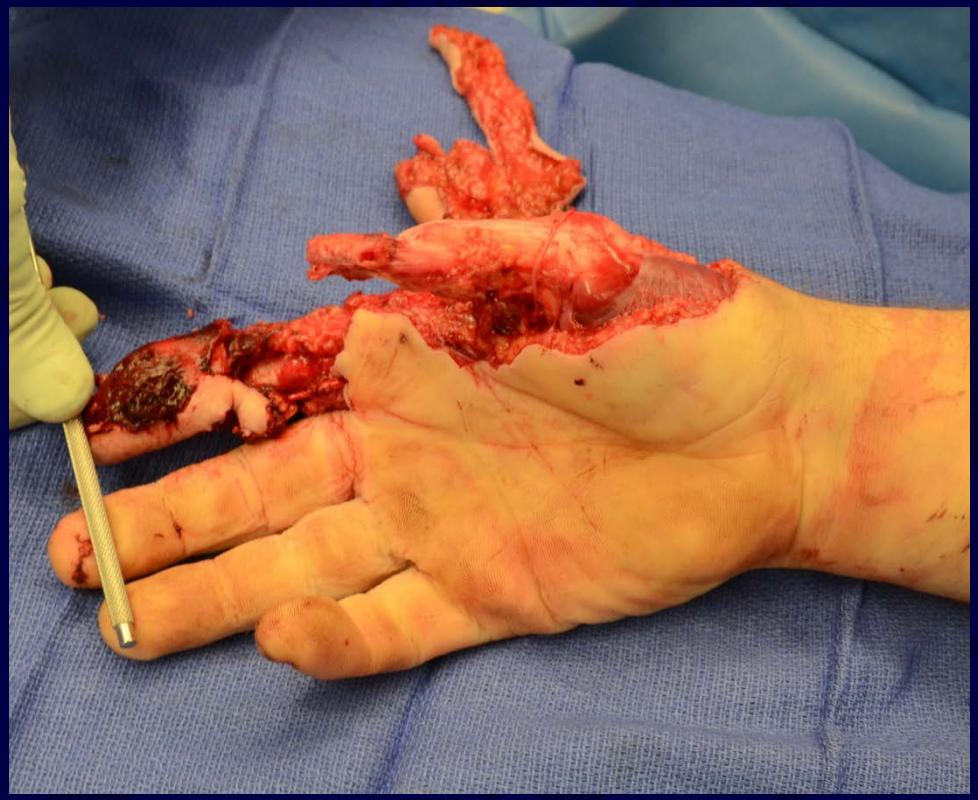
Upper Extremity Amputation



Gennadiy Busel, MD
Joao Panattoni, MD
July 2016

Amputation: Etiology

- Trauma (most common)
- Vascular Disease
- Malignancy
- Infection

Ziegler-Graham K, MacKenzie EJ, Ephraim PL, et al. Estimating the prevalence of limb loss in the United States: 2005 to 2050. Arch Phys Med Rehabil 2008;89(3):422-429.

Etiology: Trauma

- >80% of UE Amputation
- Male:Female = 4:1
- Most Amputations at level of Digit
- Major Limb Amputations less common
  - 3-15% of all amputations

Principles of UE Amputation

- Functional outcomes of amputation are drastically inferior in UE vs LE
- All efforts should be made to salvage the UE or parts to preserve function
- Consider replantation whenever possible

Tennent DJ, Wenke JC, Rivera JC, Krueger CA. Characterisation and outcomes of upper extremity amputations. Injury 2014;45 (6):965-969

Replantation

- Absolute Indication for Replantation
  - Thumb
  - Multiple Digits
  - Partial Hand
  - Wrist or Forearm
  - Almost any part in a child

Panattoni, 2011

Boulas HJ. Amputations of the fingers and hand: indications for replantation. J Am Acad Orthop Surg. 1998. Mar-Apr:6(2):100-5.

Order of Repair

Barbary et al, reviewed surgical technique and order of structures repaired during replantation

1. Bone
2. Flexors
3. Nerves
4. Arteries
5. Extensors
6. Veins
7. Skin

Barbary S, Dap F, Dautel G. Finger replantation: surgical technique and indications. Chir Main. 2013 Dec;32(6):363-72. doi: 10.1016/j.main.2013.04.012. Epub 2013 Aug 21.

Order of Repair

Order of finger replant:

- 1) Thumb 2) Long 3) Ring 4) Small 5) Index

- For multiple amputated digits structure-by-structure repair is quicker than digit-by-digit repair

- Salvage of thumb for opposition/grip is most important

Prucz RB, Friedrich JB. Upper Extremity Replantation: Current Concepts. Plast Reconstr Surg. 2014 Feb;133(2):333-42

- If not possible to replant, consider:
  - Ectopic replantation (severe contamination, unstable patient)
  - Cross limb/digit replantation
  - Spare parts (bone, tendon, nerve, skin, filet flap)
  - Preserve as much length as possible
  - Functional outcome

Contraindications to Replantation

- Severely crushed or mangled parts
- Multiple levels
- Other serious injuries or diseases
- Prolonged ischemia time
- Severe contamination
- Psychological instability

Boulas HJ. Amputations of the fingers and hand: indications for replantation. J Am Acad Orthop Surg. 1998. Mar-Apr:6(2):100-5.

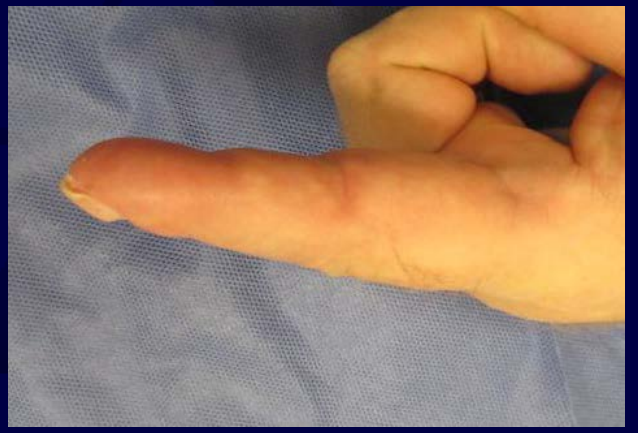
Fingertip amputation

- Commonly employed flaps
  - finger tip
    - V-Y advancement, cross finger flap, island flap (retrograde or antegrade flow), thenar flap (index or long finger only), bioengineered products (Matristem extracellular matrix).
  - thumb
    - <2cm: Moberg Advancement Flap
    - >2cm: Neurovascular island Flap (Littler) or FDMA
    - Full pulp loss: toe transfer/wrap around flap

Panattoni J, Roger De Ona I, Ahmed M. Fingertip Injuries: Surgical tips and avoiding complications. JHS Am. Vol 40, May 2015

V-Y advancement flap



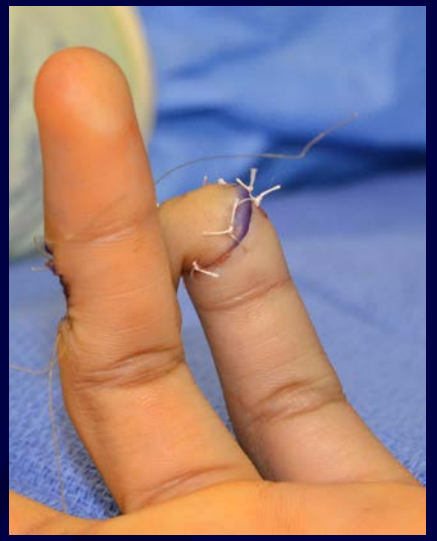
Panattoni, 2013

Cross finger flap

Panattoni, 2015

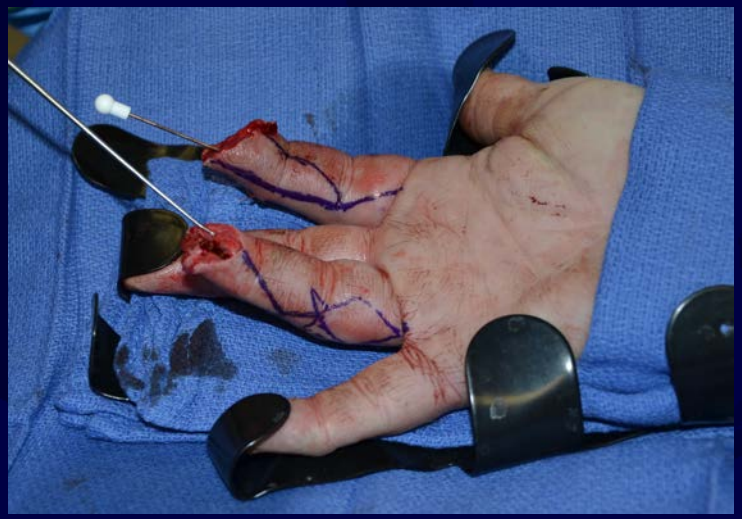
Cross finger flap






Panattoni, 2015

Island Flap



Panattoni, 2013

Index finger: antegrade flow, Ring finger: retrograde flow

Toe transfer

Panattoni, 2013

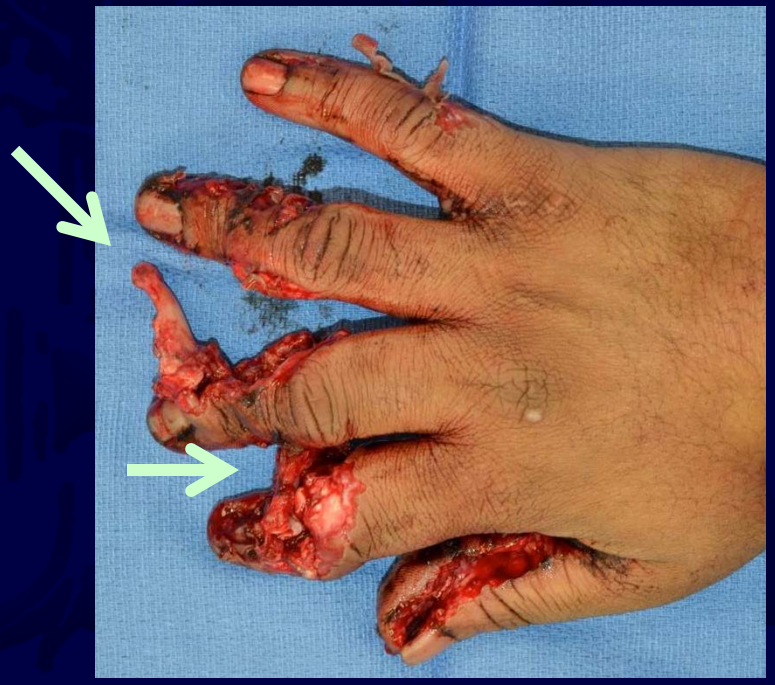
Finger/Ray amputation

- If reconstruction/replant with flap is not indicated (severe crush injuries with bone loss, contamination, patient clinically unstable), amputation should be done following the principles to optimize the functional outcome

Primary finger amputation

Severe crush injury with contamination

Bone deglovement (arrows)



Primary finger amputation

3 w s/p surgery

Panattoni, 2015

Primary amputation indication

- Severely crushed or mangled parts
- No bone support for reconstruction
- Anticipated functional outcome of amputation is superior than successful replantation or reconstruction
- Other serious injuries or diseases
- Prolonged ischemia time
- Severe contamination
- Psychological instability

Principles of finger amputation

- Debridement of all non-viable tissue
- Preserve functional length
- Smooth bone edges
- Careful handling of nerves with sharp transection allowing to retract proximally (prevent neuroma formation)

Principles of finger amputation

- DO NOT suture flexor to extensor tendons to prevent Quadrigia effect
- Prevent ingrowth nail (nail fold excision)
- Adequate skin padding (remove dog ears)
- Optimize the functional outcome (grip function)

Spare Parts Technique

- Principles:
  - Some portion of the amputated or mangled tissue is available for reconstruction
  - Digits rendered so badly damaged that function will never return should be considered for spare parts to other salvageable digits
  - Highly contaminated tissue should not be used as spare parts as this could put the patient at risk
  - Never discard any tissue until the procedure is over

Lin CH, Webb K, Neumeister MW. Immediate tissue transplantation in upper limb trauma: spare parts reconstruction. Clin Plast Surg. 2014 Jul;41(3):397-406. doi: 10.1016/j.cps.2014.04.003..

Case example:
Spare parts technique

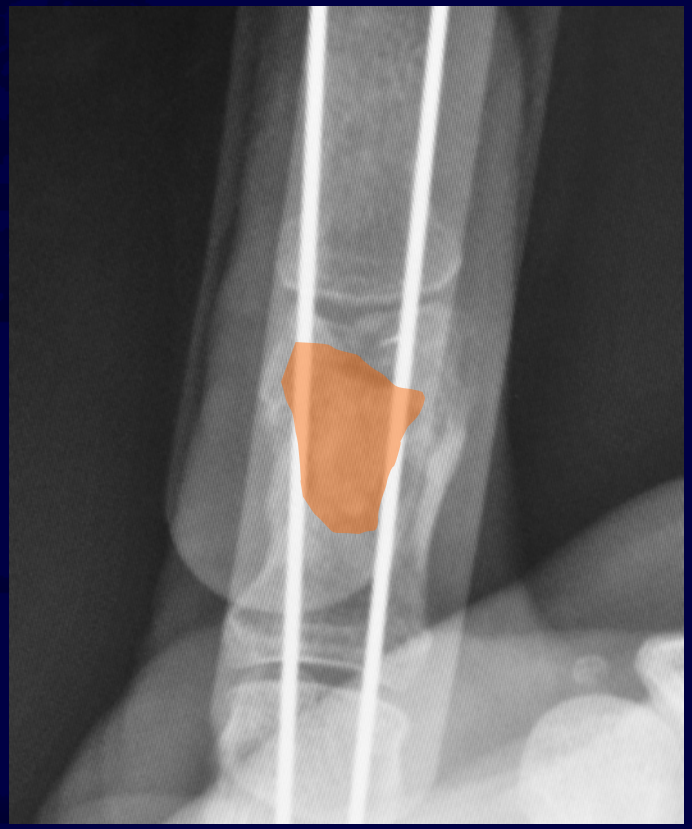
- 41 yo male, r hand GSW with highly comminuted fracture on thumb and long finger IPJ

- RLF underwent primary amputation and spare parts used to save the thumb

Panattoni, 2016

Case example 1:
Spare parts technique

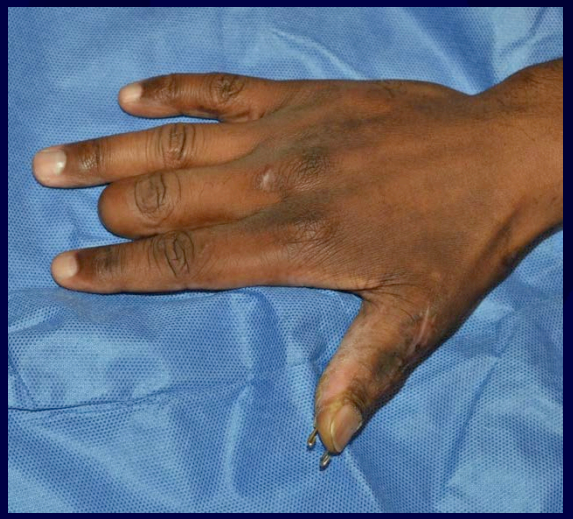
- RLF amputated P3 used as a graft to fix highly comminuted thumb P1 fracture with bone loss

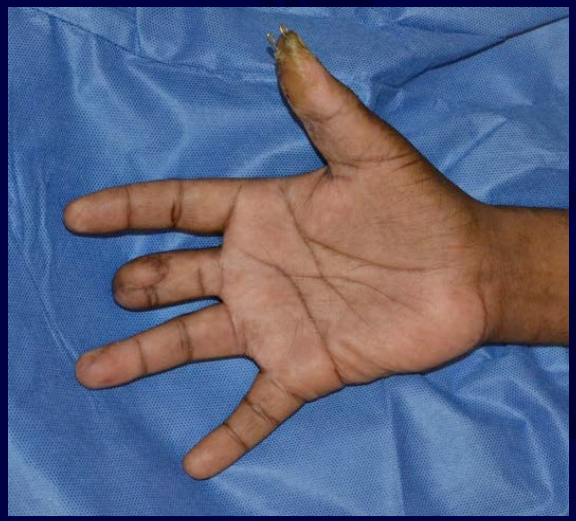


Panattoni, 2016

Case example:
Spare parts technique

- 6w s/p: functional outcome with adequate stump on amputated finger and preservation of thumb





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Ray amputation

- Excellent functional outcomes, specially on second and fifth rays
- Early recovery
- Allow the use of spare parts
  - Skin (fillet flap)
  - Nerve (graft/transfer)
  - Bone/tendon (graft/transfer)

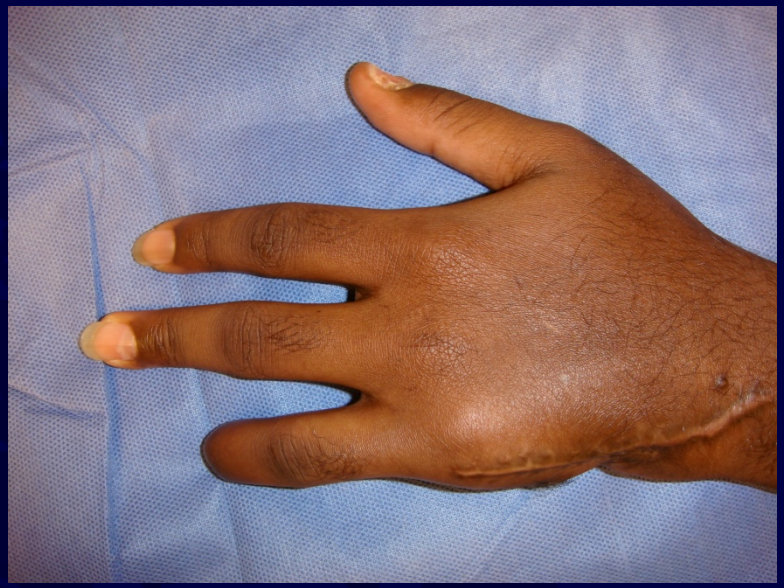
Case example:
5th ray amputation

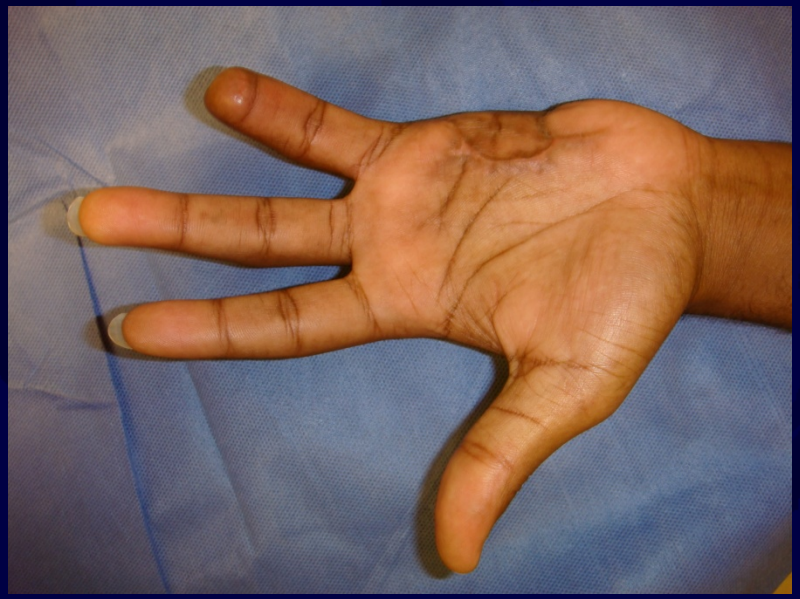
- 22 yo, GSW, severe bone loss at MPJ, skin defect

Panattoni, 2013

- IV MTC ORIF, V ray amputation and filet flap

Panattoni, 2013





Panattoni, 2013

Wrist/forearm/arm level amputations

Anatomic Considerations

- Maximize the length of the amputation stump
  - Free tissue transfer to retain length
  - Forearm: preserve prono-supination
  - Preservation of elbow and shoulder
- Neuroma prevention (cut nerves under gentle traction)
- Tenodesis (to maintain resting muscle tension)

Wolfe SW: Green's Operative Hand Surgery, ed 6. Philadelphia, PA. , Elsevier/Churchill Livingstone, 2011, pp 1885-1927

Forearm Amputation

- Most common UE amputation proximal to wrist
- Maintain minimum of 5cm of ulna for prosthesis fitting/preserve elbow flexion
- Biceps tendon transfer to ulna
- Preservation of length for maximal prono-supination
- 6-8cm of distal radius/ulna resection to provide muscle coverage

Solarz MK, Thoder JJ, Rehman S. Management of Major Traumatic Upper Extremity Amputations. Orthop Clin N Am 47 (2016) 127-136

Elbow Disarticulation

- Least common of the UE amputations
- Preserved ability for IR/ER transmission to prosthesis
- Allows for weight bearing surface when no prosthesis is used
- Preferred to trans-humeral amputation

Fitzgibbons P, Medvedev G. Functional and Clinical Outcomes of Upper Extremity Amputation. J Am Acad Orthop Surg. 2015 Dec;23(12):751-60

Rehabilitation Goals

- Residual Limb Shrinkage and Shaping
- Limb Desensitization
- Maintain joint range of motion
- Strengthen residual limb
- Maximize self reliance
- Early prosthetic fitting
- Patient education: Future goals and prosthetic options

Wolfe SW: Green's Operative Hand Surgery, ed 6. Philadelphia, PA. , Elsevier/Churchill Livingstone, 2011, pp 1885-1927

Amputation Outcomes

- Phantom limb pain is common
- Functionality and prosthetic use decreases with more proximal amputations
- Reichle et, al showed higher rate of prosthesis rejection in UE vs LE amputations 44% vs 16% respectively
  - Below-elbow amputations predicting better prosthesis use

Reichle KA, Hanley MA, Molton I, et, al. Prothesis use in persons with lower- and upper-limb amputations. J Rehabil Res Dev 2008:45(7) 961-72

Amputation Outcomes

- Reasons for revision amputations
  - HO
  - Infection
  - Neuromas
  - Contractures

* Tintle et, al showed the use of prosthesis increased from 19% to 87% after revision surgery suggesting lack of use of prosthesis may be due to reversible factors

Tintle SM, Baechler MF, Nanos GP, et, al. Reoperations following combat-related upper-extremtiy amputations. J Bone Joint Surg Am 2012; 94 (16):e1191-e1196

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12. Fitzgibbons P, Medvedev G. Functional and Clinical Outcomes of Upper Extremity Amputation. J Am Acad Orthop Surg. 2015 Dec;23(12):751-60

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15. Tintle SM, Baechler MF, Nanos GP, et, al. Reoperations following combat-related upper-extremtiy amputations. J Bone Joint Surg Am 2012; 94 (16):e1191-e1196

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