

- 1  **Comprehensive Orthopaedic Review**
Upper Extremity Amputations
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- 2  **Flap Definitions**
 - Island – flap of skin and subcutaneous tissue supported by a pedicle of nutrient vessels
 - Rotational – a local pedicle flap mobilized by counterincision at base of flap
 - Axial – a myocutaneous flap containing an artery in its long axis
 - Transposition – rectangular flap of skin repositioned to fill a defect.
 - Advancement – flap carried to its new position by sliding technique
- 3  **Volar V–Y Advancement Flap**
 - Described in 1970 by Atasoy–Kleinert
 - Preserves digital length
 - Apex of V flap is at DIPJ flexion crease
 - Base of V flap is distal, same width as pulp defect
 - Must mobilize flap carefully at level of FDP
 - Advance flap distally and inset to nailbed converting V–to–Y
- 4  **Reconstruction of the amputated fingertip with a triangular volar flap**
Atasoy et al., JBS 1970; 52A: 921–26
 - Case series – 61 patients, 64 fingers
 - Indicated for transverse or dorsal oblique pulp defects
 - Patient age range – 14 mo – 85 yrs
 - Metacarpal block anesthesia
 - Simple procedure to preserve near normal sensation
- 5  **Treatment Goals for Digital Amputations**
 - Preserve functional length (FDP, FDS intact?)
 - Durable stump coverage with useful sensitivity
 - Avoidance of symptomatic neuromas
 - Avoidance of joint contractures
 - Minimizing length of convalescence
- 6  **Flap Selection**
 - Moberg Advancement – thumb pulp defects < 1 cm (up to 2 cm in some cases)
 - Thenar – volar oblique defects, index or middle fingers, younger patients
 - Volar Atasoy V–Y or lateral Kutler V–Y – for smaller defects < 1 cm
 - Cross–finger flap – volar oblique defects
 - STSG – coverage on dorsum of finger, but not durable enough for volar coverage
 - Axial flap flap (based on first dorsal metacarpal artery) – dorsal thumb coverage
- 7  **Amputation Outcomes**
 - Morbidity is constant regardless of reconstruction method
 - Morbidity from amputation with pulp loss is function of injury itself, not rx method
 - Cold intolerance – 30%–50%
 - Sensory deficit – 30%
- 8  **Thenar Flap**
 - Preserves length of finger
 - Indicated for index or middle fingers only, best for younger patients
 - Gatewood 1926 and Flatt 1957 used one proximal flap – skin grafted donor defect
 - Smith and Albin 1976 popularized the “H flap” raising both proximal and distal flaps

- Proximal flap still used to cover pulp defect
- Distal flap used to cover donor defect at thenar eminence

9 The Thenar Flap: Analysis of 150 Cases

Melone et al., JHS 1982; 7A: 291–97

- Case series – 120 men, 30 women; 31 pts > 50 yrs
- Advantages – good color match, abundant subcutaneous tissue available for coverage, inconspicuous donor site
- Technique keys – donor site near thumb MCPJ, flex recipient MCPJ, divide pedicle at 2 weeks, start early digital motion
- PIPJ contractures in 6 patients (4%)
- Excellent tip coverage for large pulp loss, all age groups (in this study)

10 Moberg Technique

- Radial and ulnar midaxial incisions
- Flap based on both digital arteries
- Dissection at level FPL sheath
- Limit flap advancement < 1 cm
- IPJ flexion contracture most common complaint
- Cold intolerance in 10–30%

11 Functional outcome after the Moberg advancement flap in the thumb

Baumeister et al., JHS 2002; 27A: 105–14

- Case series – 36 patients with loss thumb pulp
- Independent blood supply dorsum of thumb
- All defects < 2 cm were successfully covered
- Excellent IPJ flexion, distal sensation excellent in 74%
- 22% cases required revision, 5 needed shortening (2 cm may be too much)
- Most common complaint – cold intolerance

12 Ray Amputation

- Generally not in trauma setting except for ring avulsions with skin loss to P1 level
- Usually reserved as a secondary procedure for post-traumatic impairment
- May be used as primary procedure for infection, tumor
- Improves hand cosmesis and function, but compromises grip strength

13 Transmetacarpal amputation of the index finger:

Hand strength and complications

Murray et al., JHS 1977; 2A: 471–81

- Case series – 41 patients with index ray amputations studied
- Average 20% reduction in power grip, key pinch and supination strength
- In other studies, loss of grip strength ranged from 14% to 29–34%
- 59% incidence of hyperesthesia (improved by burying digital nerves into interossei)

14 Ring Finger Ray Amputation

- Complete ring finger metacarpal excision possible since there are no tendinous attachments at its base and the hamatometacarpal joint is very mobile
- Ligaments between small finger metacarpal and hamate may be incised
- Postoperatively the small finger metacarpal will drift radially
- Gap between middle and small finger also narrowed by repairing the volar intermetacarpal ligaments distally

15 Amputation Complications

- Neuroma, dysesthesia

- Lumbrical-plus finger
- Pinch bypass (index)
- Grasping gap (central)

16 Lumbrical-Plus Finger

- FDP released and allowed to retract proximally
- Proximal retraction of FDP and lumbrical may increase tension on radial intrinsic
- Active flexion of the digit further increases tension sometimes forcing the PIPJ into paradoxical extension
- Lumbrical tenotomy permits full retraction of FDP and allows FDS to control PIPJ flexion

17 The Spiral Flap for Fingertip Resurfacing: Short-Term and Long-Term Results

Lim et al., JHS 2008; 33A: 340-47

- 32 patients with average 1.5 x 2.0 cm pulp defects
- Long-term follow-up was 13 years
- Results showed full digital ROM, normal static two-point discrimination = 4 mm
- No hypersensitivity or cold intolerance
- Level IV Therapeutic study (Singapore)

18 Factors Influencing Use of Digital Prostheses in Workers' Compensation Recipients

Hopper et al., JHS 2000; 25A: 80-85

- 178 patients completed questionnaire at 6 months post-injury
- 110 (62%) reported stump problems
- 37 (21%) indicated that stump pain interfered with prosthetic use
- Low utilization - single ring finger, stump problems, distal amputation, male gender
- No good predictor of prosthetic utilization was found

19 Prosthetic Usage in Major Upper Extremity Amputations

Wright et al., JHS 1995; 20A: 619-22

- 135 patients with prostheses after major upper extremity amputations were studied by questionnaire with a mean follow-up of 12 years
- Usage rates for prostheses: shoulder disarticulation 40%, above elbow 43%, wrist disarticulation 54%, below elbow 94%
- Patients with wrist disarticulation preferred long sensate stump to insensate prosthesis
- Below elbow amputees have highest usage rate and should have prosthesis prescribed
- Above elbow amputees, amputees with stiff shoulder and/or brachial plexus injury usually reject prosthesis

20 Myoelectric Prosthesis Definitions

- Myoplasty - connecting antagonist muscles together to maintain active muscle function
- Myodesis - attaching muscle to bone
- Tunnel cineplasty - attaching muscle to the prosthesis
- Neurotization - surgical reinnervation of denervated muscle using donor nerve
- Myotomy - cutting a muscle and allowing it to retract proximally

21 Krukenberg Procedure

- Described by Krukenberg, a German army surgeon, in 1917
- Classic indication is for bilateral hand amputee who is blind
- Forearm procedure converts radius and ulna into claw-like pincer
- Requires 8-12 cm stump, pronator teres, mobile ulnohumeral joint
- Radius is mobile ray (BR, FCR, ECRL, ECRB)

- Ulna is fixed ray (FCU, ECU, EDQ)
- Wrist extension opens the pincer, wrist flexion closes the pincer

22 Cold Intolerance

- Most common sequela of digital amputation
- More common in colder climates
- Does not improve over time
- Believed to result from initial trauma mediated by the sympathetic nervous system
- Not correlated with type of treatment, vessel patency or blood flow

23 Review Articles for Read File

- Current Concepts
Management of Fingertip Injuries
Peterson et al., JHS 2014; 39A: 2093–2101
- Surgical Technique
Reconstruction of Fingertip Injuries: Surgical Tips and Avoiding Complications
Panattoni et al., JHS 2015; 40A: 1016–24

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