Replantation in the Upper Extremity: Indications, Approach and Results

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Disclosure...
Overview

• What is replantation?
• Indications
• Technique
  • Preservation/Preparation
  • Procedure
  • Post-operative management
• Outcomes
• Economics/Litigation
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The reattachment of a body part that has been completely severed

Structures affected:

- Bones
- Tendons
- Nerves
- Arteries
- Veins
- Skin
Replantation Defined

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Revascularization:
Reattachment of an incompletely amputated part for which arterial reconstruction is necessary for viability

Not a replant...
Epidemiology

Friderich et al (2011) – 9,407 amputations

- 14.5% underwent replantation
- Replants 36 years vs. Amputation 44 years
- Replant location:
  - 27% thumbs
  - 12% digits
  - 12% hands or forearms
- 63% of amputations presented to Teaching Hospitals
  - Teaching Hospitals performed 81% of all replants
General Replant Selection Criteria

• Function must be greater than an amputation or a prosthesis
• Appearance can be important
Indications

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General Replant Considerations:

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• Appearance can be important
• Tissue viability does not equate to a successful replantation
  • “We saved the digit, but...”
• It’s all about the patient...
Indications

General Replant Considerations:

• Amputation level
• Mechanism of injury
• Ischemia time (especially if proximal)
• Chance of survival
• Expected functional outcome
• Economic impact
Relative Indications

- Thumb amputations
- Multiple digital amputations
- Single digits not in “zone 2”
- Amputations at or proximal to the palm
- Any amputated part in a child
- Sharp injuries
- Patient factors:
  - Younger, healthier, non-smoker, perceptions, economics
Relative Contraindications

- Multilevel amputations
- Severely mangled or crushed extremities or parts
- Border digits, especially the index finger
- Avulsions – “Ribbon and Red Line signs”
- Atherosclerotic vessels
- Patient factors:
  - Older, multiple comorbidities, smokers
Good Replant Candidates
Good Replant Candidates
Good Replant Candidates
Poor Replant Candidates
Poor Replant Candidates
Poor Replant Candidates

“But, Doc… I want my finger put back on… please, you have to!”
Poor Replant Candidates
Tissue Ischemia Time

If the amputated part contains muscle (amputation proximal to the fingers/thumb):

- Warm ischemia < 8 hours
- Cold ischemia < 16 hours

If the amputated part does not contain muscle (digits):

- Warm ischemia < 12 hours
- Cold ischemia < 24 hours (but reports of success beyond 96 hours)
Ring Avulsions

Degloving injury associated with traumatic and forced removal of a ring

- Injuries proximal to the proximal interphalangeal joint have worst prognosis – Amputate these
Technique - Preservation

Field preparation of the amputated part
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• Wrap the clean part in saline moistened gauze
Field preparation of the amputated part

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- Place the wrapped part in a sealed plastic bag
Field preparation of the amputated part

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- Placed the sealed plastic bag in an ice water bath
Technique - Preservation

1. Wash amputated part with water to remove gross contaminants

2. Wrap amputated part in moist gauze

3. Place wrapped amputated part in dry plastic bag

4. Place bag with amputated part in another plastic bag with ice

Technique of preservation of an amputated part(s) for transport to a hospital
Technique - Preservation
Technique – Initial Management

Emergency Department

• Both the patient and part require attention
• Evaluate associated injuries and stabilize the patient
• Remove tourniquets
• Image both the injured limb and the part
• Do not ligate or clip vessels
Technique – Initial Management

Emergency Department

• Splint hand in functional position (intrinsic plus)
• Cover the stump with non-adherent dressing
Technique – Initial Management

Emergency Department

• Splint hand in functional position (intrinsic plus)
• Cover the stump with non-adherent dressing
• NPO
• Check tetanus status
Technique – Initial Management

Preoperative Medications

• Ancef 2g IV
• Aspirin 325mg
Managing Expectations

• Establish a relationship before the diagnosis and plan
• Emotionally charged time for the patient and family
• Transferred to “experts”
• Most important for patients to feel that you will try
• Don’t make promises
Technique – Replantation Surgery

General Principles

• Two team approach – one for the part(s), one for the patient
• Keep parts cool until circulation reestablished
• Consider a block in conjunction with general anesthesia
• For multiple parts, repair by structure rather than by region
Technique – Replantation Surgery

Prepare the amputated part

• Identify structures
• Prepare the bone for fixation
• Prepare the tendons for suture repair
• Cool the part
Technique – Replantation Surgery

Surgical sequence

• Debridement (mid-lateral incisions)
• Stabilize fractures
• Repair extensor tendons
• Repair flexor tendons
• Repair artery
• Repair nerves
• Repair veins
• Skin Coverage
Technique – Replantation Surgery

Debridement (mid-lateral incisions)

• Allows greater access to structures
• Less skin compromise
Technique – Replantation Surgery

Stabilize fractures

- Interosseous wiring
- Pinning
- Plates and screws
- Consider shortening or other non-anatomic fixation
  - 5mm to 1 cm for digits
  - 2 to 4 cm proximal to the hand
Technique – Replantation Surgery

Interosseous Wiring

• Technique
  • Drill with 0.35 inch K-wire
  • Insert 20 gauge needle
  • Pass 26 gauge wire

• Benefits
  • Rigid
  • Stable
  • Low profile
Technique – Replantation Surgery

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Repair tendons

• Extensor
  • 3-0 (digits) 2-0 Ethibond (proximal)

• Flexor
  • Place core suture
  • Do not tie until after microvascular work complete (digit can be maintained in extension)
  • Primary repairs function much better than secondary/graft repairs
Technique – Replantation Surgery

Arterial repair

• Must be tension free
• Must repair segments with normal intima
• 1 vs. 2 arteries
• Heparin (3-5,000) units prior to first anastomosis
  • Highly variable
Technique – Replantation Surgery

Venous repair

• Must be tension free
• Two veins for each arterial repair
• Often the limiting step of replantation viability/success
• Alternative drainage techniques
  • Distal artery to proximal vein
  • Heparin pledgets to nail bed
  • Leeches
Leeches

- Will not adhere to avascular tissues
- Engorge and detach in 15-30 minutes
- Hirudin promotes oozing from tissues for 8-12 hours
- Must cover patient for:
  - Aeromonas hydrophilia
  - Serratia marcescens
  - Cipro covers both organisms
  - Monitor hematocrit
Technique – Replantation Surgery

Nerve repair

• Ultimately, sensibility of replant closely tied to functional use
• Primary repair if possible (shortening is favored over graft)
• If tension free repair is not possible, graft is preferred
  • Use spare parts
Technique – Post-operative Care

- Non-compressive bulky dressing with splints
- Warm room (80 degrees) and Bair Hugger to extremity
- No smoking, caffeine or chocolate
- Limit activity for 3-5 days
- Consider indwelling catheter for analgesia
- If chance of takeback, NPO for 24-48 hours and Q2h NV monitoring
Technique – Post-operative Care

Postoperative Medications

• IV fluids
  • NPO
  • Prevent hypotension/peripheral vasoconstriction

• Anticoagulation
  • Aspirin
  • Heparin
  • Lovenox
  • Dextran
Postoperative Medications

• Antibiotics
  • Most often for 1 week

• Analgesia / Anxiolytics
  • Blocks
  • Medications
Technique – Post-operative Care

The failing replant...

• Inspect dressing for constrictions
• Depress or elevate hand
• Heparin bolus
• Improved pain control
• Hydration
• Thrombolytics
• Relieve congestion
• Re-exploration
Technique – Proximal replantation

Major limb replantation

• Ischemia time is critical
  • Use shunts proximal to metacarpals
• Rapid, stable fixation
• Shorten limb as needed
• Arterial repair prior to venous repair
• Anticoagulants discouraged
• Preserve life over limb
Outcomes

Survival rates

• Recent reports suggest 50-60% survival of replants

• Positive predictors
  • Sharp mechanism of injury
  • Radial sided amputations
  • Non-smokers

• Negative predictors
  • Avulsion injuries
  • Prolonged ischemia
  • Inappropriate preservation of part
  • Diabetes
Outcomes

Functional Outcomes

• Tissue survival does not equate to a functional extremity

• Range of Motion
  • Typically half that of normal
  • Zone 2 levels much worse than others
  • Tendon adhesions and joint stiffness common
  • 60% reoperation rate due to range of motion limitations
Outcomes

Functional Outcomes

• Single digit replants
  • Weaker grip strength than amputations
  • Poorer functional outcome than amputations

• Thumb and multi-digit replantation
  • Improved grip strength and functional outcomes versus amputation
Outcomes

Sensibility

• Two-point discrimination
  • Normal is < 5mm
  • ~8mm for sharp injuries
  • ~15mm for avulsion injuries

• Regained sensibility is highly correlated with patient satisfaction following replantation

• Allotransplants have higher rates and degree of nerve recovery than replants
Outcomes

Cold sensitivity

• Nearly universal
• Develops within the first year
• Does not improve with time
• Arterial inflow?
  • 37% of successful replants demonstrate arterial occlusion within 15 days
  • Perfusion maintained via soft tissue neovascularization
Outcomes – Why bother??

Functional outcomes

• Digital replants outside of zone 2 can be very successful

• Distal digital replantation
  • 98% return to previous work
  • Satisfied with cosmetic and functional outcome

• Thumb replantation
  • 87% of patients returned to previous work

• Hand replantation in surgeons
  • 183 surgeons with replantation at various levels
  • 3 claimed disability
  • Remainder continued to work as surgeons
Cost of replantation

- Direct costs for digital replantation
  - Medical Costs: $42,561 ($27,541)
  - Average hospital stay 5.8 days (3.5 days)
  - Return to work at 125 days (60 days)
  - Does not include repeat surgeries

- Indirect costs
  - $14,200 in lost wages
Chung et al 2012

- “Immediate and consistent” access for microvascular replantation
  - Level I Trauma Centers: 55%
    - (29% provide no coverage at all – Peterson et al 2012)
    - Level II Trauma Centers: 29%

- 906 Hospitals Surveyed
  - 15% performed a replantation in study year
  - 60% of those performed only one case
  - 2% performed > 10 cases
Brown et al 2017

- 3417 digital amputations between 2008-2012
  - 631 replantations attempted (18%)
  - Success rate 64-75%
  - Facilities with > 5 replants per year had significantly higher success rates
  - “High volume centers and regionalization of replantation should be a priority”
Economics – Liability

Bastidas et al 2011

• Review of all lawsuits related to replantation over an 8 year period – Bellevue Hospital (L1)
  • No claims filed for replantation of the proximal to the hand
  • 23 lawsuits filed
  • 13 (56.5%) based on decision not to replant
  • One claim successfully settled for $45,000 due to disposal of amputated part (referral facility)
  • Low incidence of successful litigation for replantation attempts
  • Higher concern for litigation related to decision not to attempt replant
• Replantation can be quite successful and lead to a high degree of patient satisfaction when appropriately indicated
• Appropriate indications for replantation are declining; currently approximately 15% of upper extremity amputations
• The patient must be engaged and considered when exploring options for upper extremity amputations
• Outcomes are more successful at institutions that regularly perform microvascular replantations
• Only 55% of Level 1 Trauma Centers provide 24/7/365 availability of microvascular replantations services; 29% do not provide coverage at all
• Legal risk is highest when not proceeding with replantation
Thank You