Upper Extremity Trauma, CRPS, and Phantom Limb Syndrome

Gonzalo Barinaga, MD

Hand and Upper Extremity

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Disclosure

- I have no financial conflicts associated with this presentation.

Amputation: Presentation Goals

- Etiology and indications for amputations and replantation
- Immediate care of amputations
- Techniques
- Prosthetics and Rehabilitation

Etiology: Trauma

- 90% of Upper Extremity Amputation
- Male:Female = 4:1
- Most Amputations at level of Digit
- Major Limb Amputations less common
- Revascularization sometimes possible for partial amputations
- Replantation sometimes possible for complete amputation

SCIENTIFIC ARTICLE

Epidemiology of Upper Extremity Replantation Surgery in the United States

Jeffrey B. Friedrich, MD, Louis H. Poppler, MD, Christopher D. Mack, MS, Frederick P. Rivara, MD, MPH, L. Scott Levin, MD, Matthew B. Klein, MD, MS

- 1361 of 9407 cases of upper extremity amputation underwent replantation in US during the years 2001, 2004, 2007
- Only 27% of patients with thumb amp underwent replantation
  - Only 12% of patients with digit amp and 12% with hand/arm amp

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J Hand Surg Am. 2011 Nov;36(11):1835-40

Current Practice of Microsurgery by Members of the American Society for Surgery of the Hand

Alexander H. Payatakes, MD, Nikolaos P. Zagoreos, MD,
Gregory G. Fedorcik, MD, David S. Ruch, MD, L. Scott Levin, MD

From the Department of Surgery, Divisions of Orthopaedic Surgery and Plastic and Reconstructive Surgery, Duke University Medical Center, Durham, NC.

- 561 respondents
- 56% perform replants
  - 62 % perform < 5 per year
- 74% have observed less attempts over past 10 years
  - Narrow indications, fewer amps, declining reimbursement

J Hand Surg Am. 2007 Apr;32(4):541-7

Hand and Microvascular — Replantation Call Availability Study: A National Real-time Survey of Level 1 and 2 Trauma Centers

Not a clinical study

♦ **Bret C. Peterson, MD**
Daniel Mangiapani, BS
Ryan Kellogg, BS
Fraser J. Leversedge, MD

- ASSH Annual Meeting, Las Vegas, NV 2011
- ~ 55% of Level I trauma centers and 30% of Level II trauma centers have on-call coverage for replantation procedures

EVALUATION OF PARTIAL AMPUTATIONS

- History
  - Age, Hand Dominance, Occupation, PMH
- Mechanism of Injury
  - Sharp transection vs. crushing or avulsion
    - Ask a detailed history of exactly what happened to the extremity
- Physical Exam
  - Associated injuries, X-rays

EVALUATION OF PARTIAL AMPUTATIONS

- Assessing the digit or hand
  - Visual inspection
    - White vs mottled/congested
    - Turgor
  - Capillary refill
    - Not always reliable as a congested struggling digit will still have cap refill
  - Needle poke test
  - Doppler assessment
  - PULSE OXIMETRY

EVALUATION OF COMPLETE AMPUTATIONS

- History
  - Age, Hand Dominance, Occupation, PMH
- Mechanism of Injury
  - Sharp vs. crushing or avulsion
- Physical Exam
  - Associated injuries, X-rays
  - Ensure hemostasis and prevent exsanguination
  - Use tourniquets **very judiciously and never for >2 hours at a time**

Management of the Amputated Part

- The amputated part should be cooled but not frozen
- Never place the amputated part directly on ice or into ice water (frostbite injury)
- Wrap part in moist saline gauze and place in sealed plastic bag; set in ice and water slurry

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PATIENT SELECTION FOR REPLANTATION

- Success is not measured by survival
- Extent of return of function
- Function anticipated after replantation should be better than expected with amputation or prosthesis

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Amputation: Trauma and Replantation

- Candidates for Replantation after Trauma
  - 1. Thumb
  - 2. Multiple Digits
  - 3. Partial Hand
  - 4. Wrist or Forearm
  - 5. Above Elbow
  - 6. Isolated Digit Distal to FDS insertion
  - 7. Almost any part in child

Amputation: Trauma and Replantation

- Candidates for Replantation after Trauma
  - Clean cut
  - Limited crush
  - Limited contamination
  - Acceptable ischemia time for replantation
    - 6 hours with muscle (anything from mid-palm level proximal)
    - 12-48 hours with digit
      - 12 hours of warm ischemia
      - 24-48 hours of cold ischemia (up to 94 hours reported)

- The ideal patient:
  - young
  - healthy
  - nonsmoker
  - without any significant medical co-morbidities
  - without other major injuries

- The ideal injury:
- sharp guillotine-type amputation
- minimal tissue destruction and contamination

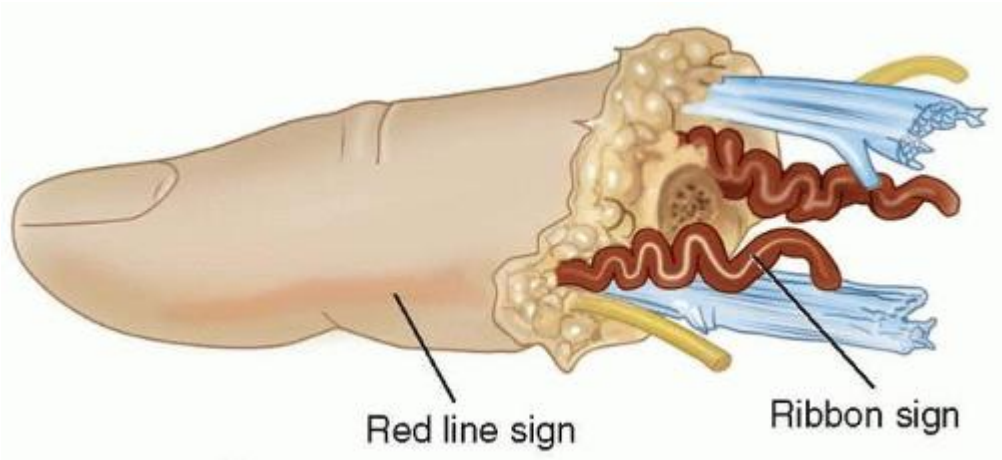
Amputation: Replantation

- Poor Candidates for Replantation
  - 1. Severely crushed or mangled parts
  - 2. Multiple levels
  - 3. Other serious injuries or diseases
  - 4. Atherosclerotic vessels
  - 5. Mentally unstable
  - 6. > allotted ischemia time
  - 7. Severe contamination

- Single digit in Zone II (especially index)
  - “Why I Hate the Index Finger” – W. White 1980

Ribbon Sign

- Coiling or tortuosity of digital arteries
- Indicative of significant injury



Surgical Technique: Digit Replantation

- 1. Identify Vessels and Nerves
- 2. Debride
- 3. Shorten and fix bone
- 4. Repair Extensor Tendon
- 5. Repair Flexor Tendon
- 6. Repair Nerves
- 7. Repair Arteries
- 8. Repair Veins
- 9. Skin Closure (skin graft if necessary)

Repair Veins!

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Replantation: Multiple Digits

DISTAL TIP REPLANTS

- Distal to Sublimus
- Excellent prognosis
- Primary fusion if DIP involved
- Veins hard to find
  - Remove nail plate
    - Heparin soaked pledgets
    - Leeches
    - AV anastomosis
      - Distal A. to proximal V.

Major Limb Replantation

- Ischemia time critical
- Bone shortening and extensive muscle debridement
- May use shunt proximal to the metacarpal level
- Rapid, yet stable bony fixation
- Always need fasciotomies
- Cover exposed vessels with meshed STSG
- Reperfusion injury and muscle metabolites after proximal replants (acidosis)
- Secondary debridement

Upper Arm Amputations

- Avulsion injuries
  - Associated injuries to subclavian vessels, brachial plexus, intrathoracic structures
  - Horner's sign
    - Bad prognosis; replantation to be avoided
- Multiple level arm amputation
  - Distal amputation; replant proximal portion
  - Improve fitting for prosthesis
  - Salvage elbow joint

Amputation: Major Limb Replantation Outcomes

- >2/3 survival rate
- Can be a life threatening undertaking
- Multiple Surgeries often required
  - Late Nerve, Bone, Tendon Surgeries
- Function of major upper extremity replantations even though poor can be superior to prosthetic function

Ectopic “banking” of amputated parts

- Indicated for extensive injuries with adequate amputated part in setting of contaminated or absent support structures.
- Recipient sites described- anterior thorax, contralateral arm/leg, groin. High complication rate.
- Largest and original series described by Marko Godina 1986.

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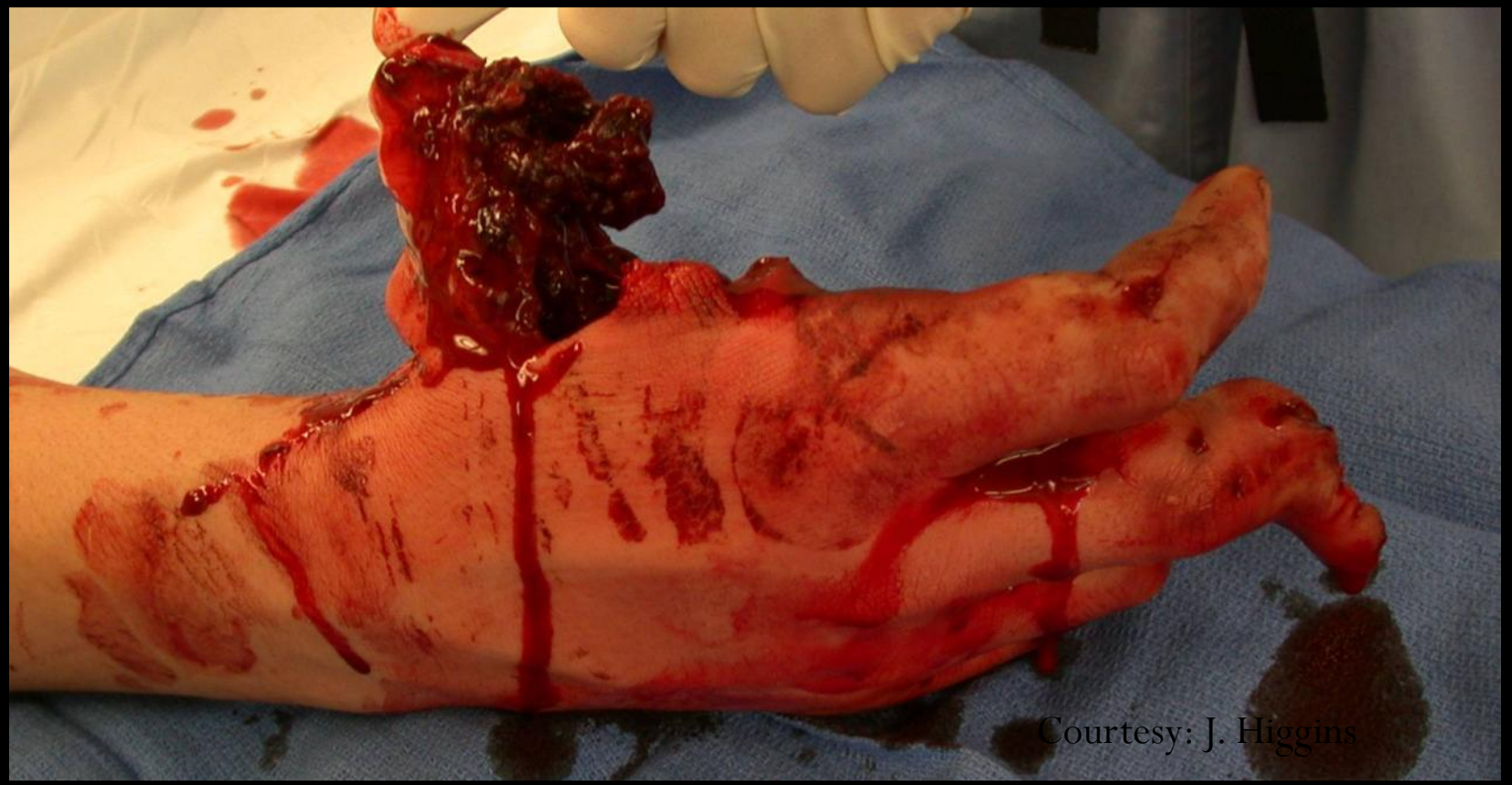

Courtesy: J. Higgins

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Grip strength 80 # (unaffected side 100#)
Injured right hand has remained dominant hand

Upper vs Lower Limb

- Upper extremity nonweightbearing
  - Less durable skin acceptable
  - Decreased sensation better tolerated
  - Joint deformity better tolerated
  - Late amputations rare
  - Transplants now being performed

- Lower Limb
  - Salvage versus amputation
  - Amputation and prostheses of the lower extremity are more functional than the upper extremity.

Psychological Adaptation

- Amputation represents loss of function, sensation and body image
- Psychological response is determined by many variables
  - Psychosocial/Age
  - Personality
  - Coping Strategies
  - Economic/Vocational
  - Health
  - Reason for amputation

Psychological Adaptation

- Up to 2/3 of amputees will manifest postoperative psychiatric symptoms
  - Depression
  - Anxiety
  - Crying spells
  - Insomnia
  - Loss of appetite
  - Suicidal ideation

Psychological Adaptation: Stages

- 1. Preoperative
  - Tumor, Vascular Disease, Chronic Infection
  - Support Groups
- 2. Immediate Postoperative
  - Hours to days
  - Safety, Pain, Disfigurement
- 3. In-Hospital Rehabilitation
- 4. At-Home Rehabilitation

In-Hospital Rehabilitation

- Initial: concerns about safety, pain, disfigurement
- Later: emphasis shifts to social reintegration and vocational adjustments

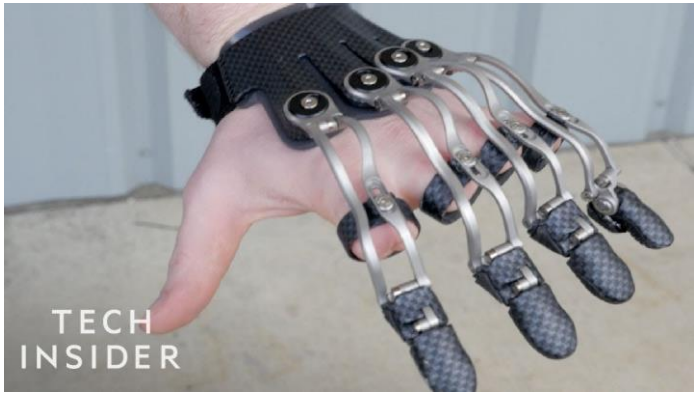
- Grief Response:
  - 1. “numbness” or denial
  - 2. yearning for what is lost
  - 3. Disorganization: all hope is lost for recovery of lost part
  - 4. Reorganization

Management of Amputee

- Preparation
- Good Surgical Technique
- Rehabilitation (both physical and psychological)
- Early Prosthetic Fitting
- Team Approach
- Vocational and Activity Rehabilitation

Prosthetics

- Passive
  - Cosmetic
- Body Powered
  - Harnesses and cables
- Myoelectric
  - Surface EMG
  - Activation delay
- Neuroprosthetics



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Case Example

- 35 year old male worker in Blue River, WI amputates his thumb working on a farm. He is in shock, it takes an hour before he finds someone to help him. They arrange a vehicle to get him to urgent care in Dodgeville, 45 minutes away. By the time he is seen by an ER doctor, 150 minutes have passed. The thumb does not have a clean cut, it has been wrapped in a towel at room temperature. The first available trauma specialist surgeon would be available 3 hours later. At a minimum of six hours later, what is the likelihood that thumb can/will be determined to be replanted? 0% chance, 25% chance, 50% chance, 100% chance

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Complex Regional Pain Syndrome

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Complex Regional Pain Syndrome

- Reflex sympathetic dystrophy
- Causalgia
- Algodystrophy
- Neurodystrophy
- Neurovascular dystrophy
- Mimocausalgia
- Posttraumatic pain syndrome

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Demographics and Risk Factors

- 26.2 per 100,000 person-years
- Females are 3-4x more likely than males
- Mean age is 46-53 yrs old
- Incidence is higher in smokers
- Genetic predisposition is postulated but not confirmed
- If treated within one year will have better prognosis
- Fractures are the most common inciting injury

Pain

- Nociceptive: pain that arises from actual or threatened damage to nonneural tissue and is secondary to the activation of nociceptors
- Neuropathic: pain initiated or caused by a primary lesion or dysfunction in the nervous system)
- Nocicplastic: pain that arises from altered nociception despite no clear evidence of actual or threatened tissue damage causing the activation of peripheral nociceptors or evidence for disease or lesion of the somatosensory system in origin.

Pain

- Pain
  - Personal
  - Cognitive
  - Emotional
- Types of Pain
  - Nociceptive
  - Neuropathic

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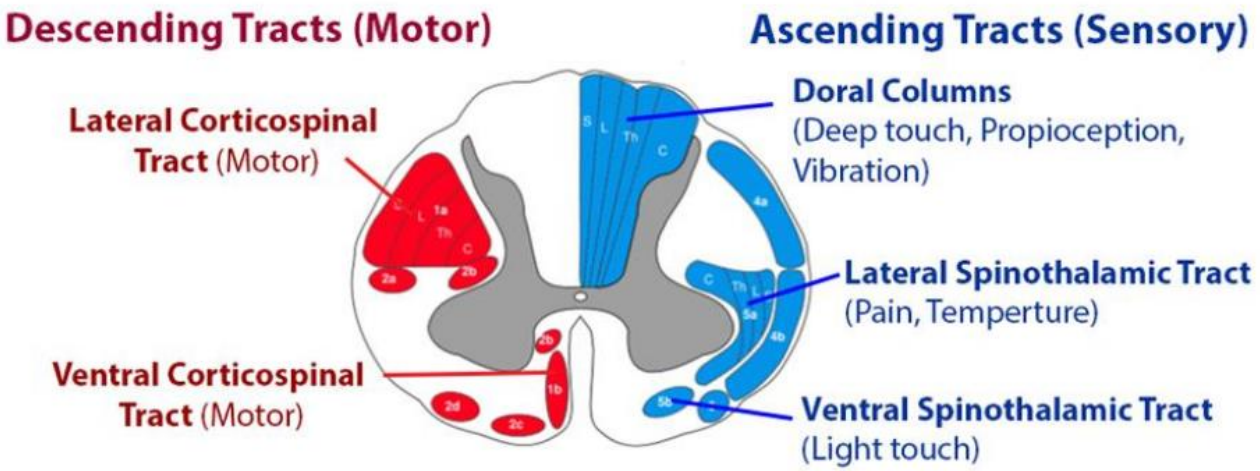
J Am Acad Orthop Surg 2004;12:213-220

Nociceptive



- damage to the *skin* or other *peripheral tissue*
- normal sensory receptors via afferent neurons to the dorsal horn, then through normal ascending spinothalamic pathways to higher neural centers
- Local pain, not dermatomal
- protective

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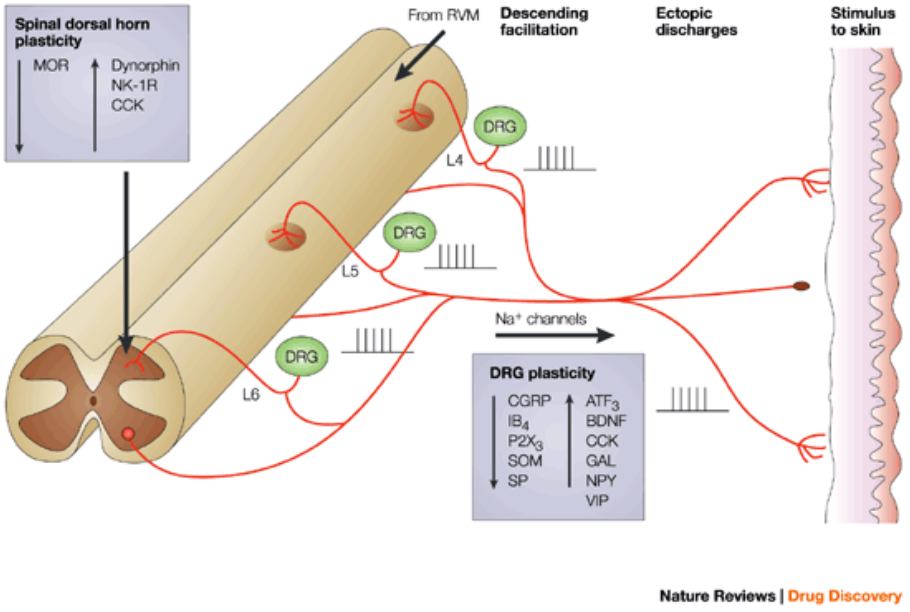
Neuropathic

- Damage: peripheral nerve, nerve root, SC
- Pain is out of proportion to stimulus intensity ; *sometimes referred/dermatomal*
  - Allodynia: pain from a stimulus that is not normally painful
  - Hyperpathia or Hyperalgesia: greater-than normal pain sensation from a normally painful stimulus
  - Dysesthesias: painful



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Neuropathic

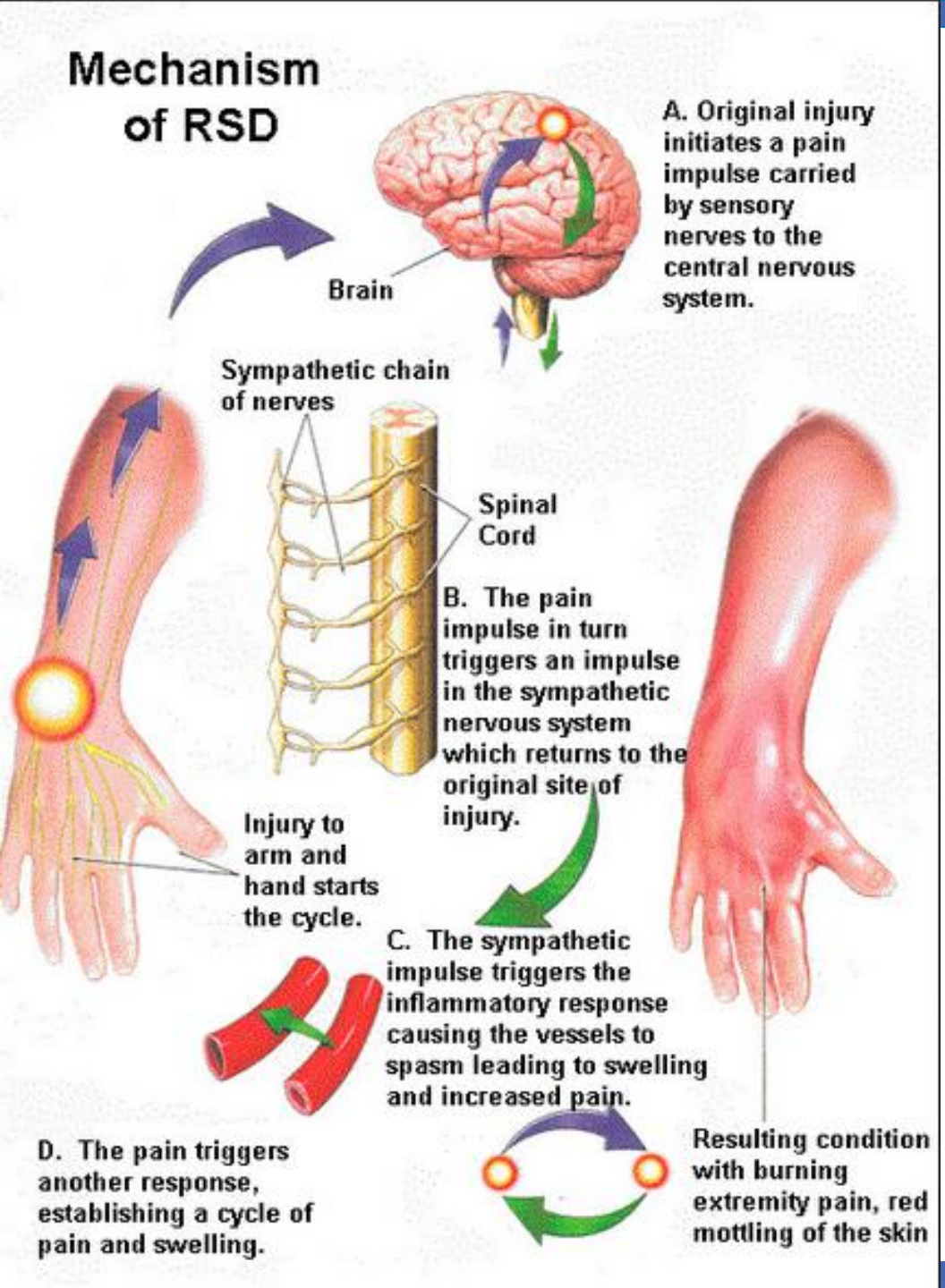
- SMP: Sympathetically Maintained Pain
- Examples of neuropathic pain:
  - phantom limb pain
  - peripheral neuropathies (eg, in diabetes)
  - radiculopathy
  - spinal cord injury
  - thalamic lesions
  - cortical or subcortical damage
  - complex regional pain syndrome (neural vs. non)

Complex Regional Pain Syndrome

- Historically , first described during the American Civil War
  - Causalgia
  - Etymology: Gk, *kausis,* burning, *algos,* pain
- Others: posttraumatic spreading neuralgia, shoulder hand syndrome, Sudeck's atrophy, Sympathalgia

- 1940s:
  - Reflex sympathetic dystrophy
  - based on the theory that sympathetic hyperactivity was involved in the pathophysiology

- In 1993:
  - Consensus workshop: International Association for the Study of Pain
  - Complex Regional pain syndrome



- Exact pathophysiology is unknown

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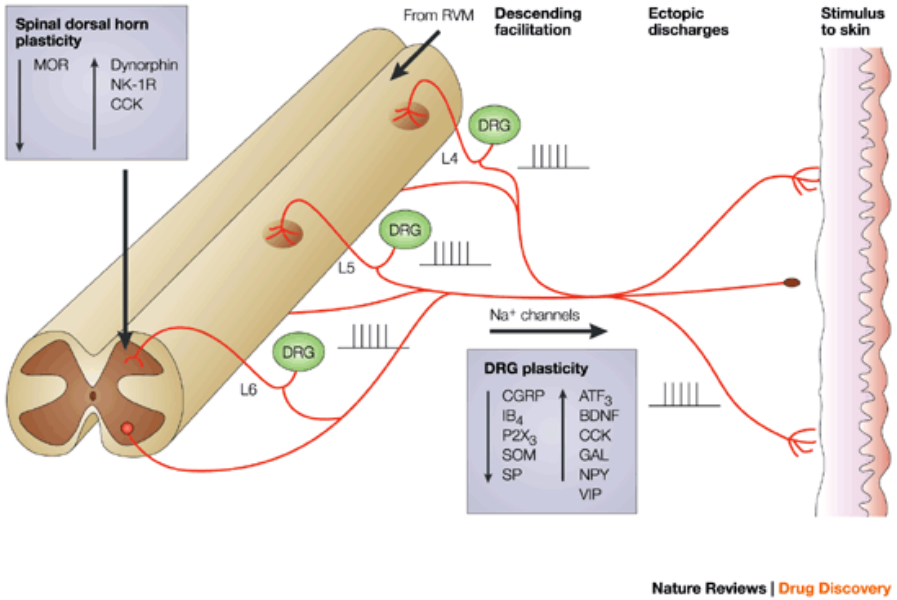
Neuropathic

- Peripheral nerve injury
- Ectopic discharges initiated at the site of injury, at the dorsal root ganglia (DRG) or in adjacent fibers
- Cause spinal sensitization through:
  - *N*-methyl-D-aspartate (NMDA) receptors and upregulation of spinal dynorphin
  - Descending facilitation from the rostral ventral medulla (RVM) is also important in modulating neurotransmission of sensory information and serves to maintain the neuropathic state
  - Neuroplastic changes in the spinal dorsal horn and the DRG include upregulation and downregulation of various neurotransmitters, neurotransmitter receptors and other markers
  - As a result, the painful response to a stimulus to the skin is amplified



Complex Regional Pain Syndrome

- Epidemiology
  - incidence of CRPS both type 1 & 2 are about 1% to 15%
  - higher occurrence of CRPS in females (3:1)
  - 2-5 % of those with peripheral nerve injury
  - 13-70 % of those with heiplegia
  - affected age group is between 18 and 71 years with a mean age of 41.8 years
  - CRPS can also occur in children
    - DM
  - Smoking
  - Genetics

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Pain; 80:539-544, 1999

Complex Regional Pain Syndrome

- can result from damage to nonneural or neural tissue
-
  - occurs when *an injury to nonneural tissue* result
    - autonomic dysfunction
    - atrophy
    - *nondermatomal* pain
    - hyperalgesia
    - pain out of proportion to the inciting event
-
  - is like type 1, but the *injury involves a nerve*
  - pain pattern is often more confined and some times *dermatomal*

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Complex Regional Pain Syndrome

- Causes:
  - trauma from an exaggerated response to injury
    - most common reason for a poor outcome following a crush injury to the foot
  - surgery
  - prolonged immobilization
  - possible malingering

Photo courtesy of Dr. Steven Richelmer.

Figure 1. Image of a patient with lower extremity complex regional pain syndrome.

Complex Regional Pain Syndrome

- Prevention:
  - Vitamin C 500 mg daily is an effective prophylactic agent in distal radius fractures treated with conservative management
  - avoid tight dressings and prolonged immobilization
  - Elevation
  - Early digital motion
- Zollinger et al (JBJS 2007)
  - Multicenter RCT non-op and operative
  - 2.4% vs. 10.1%

J Am Acad Orthop Surg 2009;17:369-77

Lankford and Evans Stages of RSD

Stages	Duration	Signs & Symptoms
Stage I	Usually last two to six weeks but may last up to six month	Skin changes: Initially warm and dry, later cold and cyanotic. Mottling of the skin Sweat changes: Hyperhydrosis Temperature changes: Usually increase Edema: Non pitting Pain: Usually not significant, tenderness and hyperesthesia may happen
Stages II	Starts two to six week after initial injury and may last up to three to six month	Skin changes: Cool, pale, mottled cyanotic and a shiny appearance Sweat Changes: Hyperhydrosis Temperature: Usually decrease Edema: Extensive edema with a indurated and brawny character. Pain: Diffuse, constant, burning, and increased by stimuli. Hyperesthesia, Hyperalgesia and allodynia may also be present
Stage III	Starts six to eight months after the initial injury, last for unpredictable period.	Skin changes: Irreversible atrophy Fat and Muscles changes: Irreversible atrophy Temperature changes: Decrease Joint changes: Decrease range of motion and decrease strength. Pain: Intractable, Hyperesthesia, Hyperalgesia and allodynia may also be present X-rays Findings: Diffuse demineralization.

- Normal x-rays, positive three-phase bone scan\
- Osteopenia on x-ray
- Staging by TIMING is controversial

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Complex Regional Pain Syndrome

Differential Diagnoses of Complex Regional Pain Syndrome
Soft-tissue infection
Osteitis
Fracture nonunion
Rheumatoid arthritis
Neurological disorders (ie, polyneuropathy, neuritis, etc)
Malignant tumors

- Laboratory
  - Substance P
  - Bradykinin
  - calcitonin gene-related peptide
  - Normal ESR and CRP

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Complex Regional Pain Syndrome

- Cardinal signs
  - exaggerated pain
  - swelling
  - stiffness
  - skin discoloration
- Physical exam
  - vasomotor disturbance
  - trophic skin changes
  - hyperhidrosis
  - "flamingo gait" if the knee is involved

Photo courtesy of Dr. Steven Richelmer.

Figure 1. Image of a patient with lower extremity complex regional pain syndro

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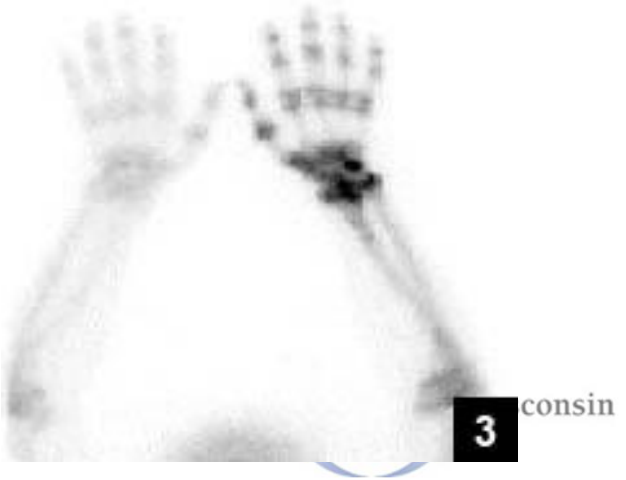
Complex Regional Pain Syndrome

- Xray
  - diffuse osteoporosis with a severe patchy demineralization
  - especially of the periarticular regions
  - subperiostal bone resorption
- Bonescan
  - Only sensitive during first 20-26 weeks
    - Accelerated blood flow into the affected limb
    - increased diffuse activity during the blood pool phase
    - *increased periarticular uptake in the delayed static phase*

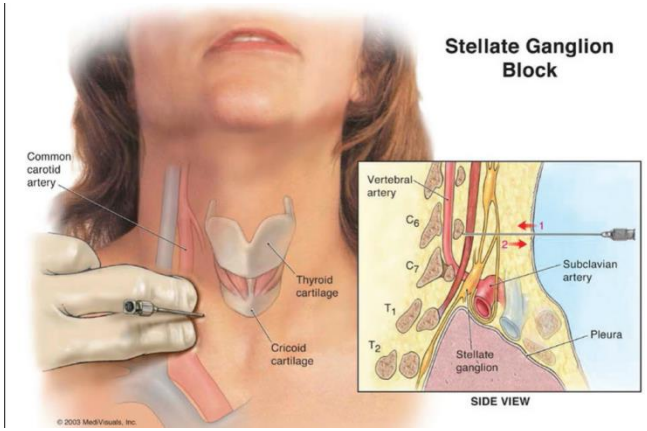


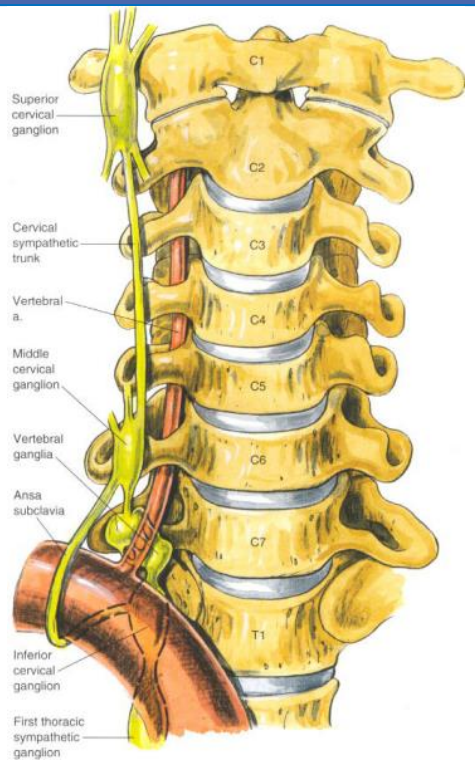
IMPORTANT

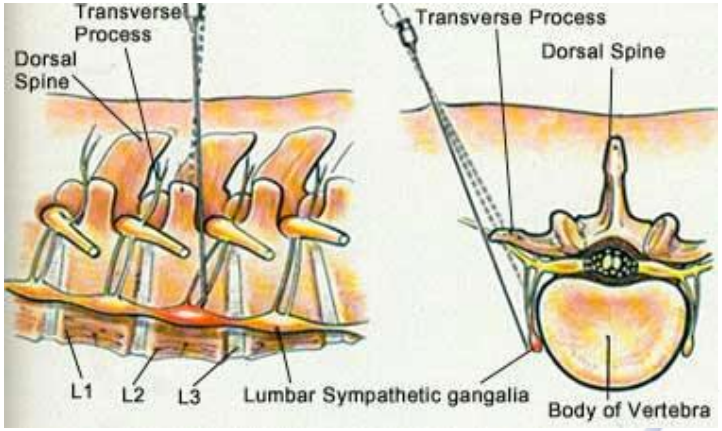
- Attempts to identify a pathognomonic marker for CRPS remain unsuccessful; there are no diagnostic tools, serum biomarkers, or laboratory findings that define the condition.
- It is a clinical diagnosis

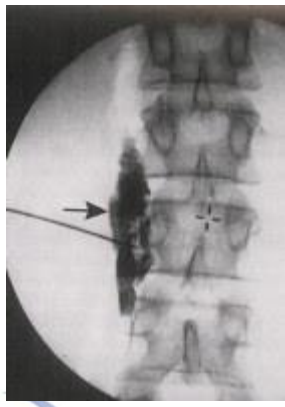
CRPS

- Diagnosis is clinical
- Sympathetic block
  - Stellate ganglion block
    - UE block
    - Horner's syndrome (meiosis, ptosis, anhydrosis and enophthalmos) often develops after successful block
  - Lumbar sympathetic block
    - lower extremity
  - Optimal block increases the temperature of the skin of the affected part









Complex Regional Pain Syndrome

- CRPS has both physical and psychological factors
  - reduced quality of life
  - impaired occupational function
  - anxiety
  - increased depression
  - suicide

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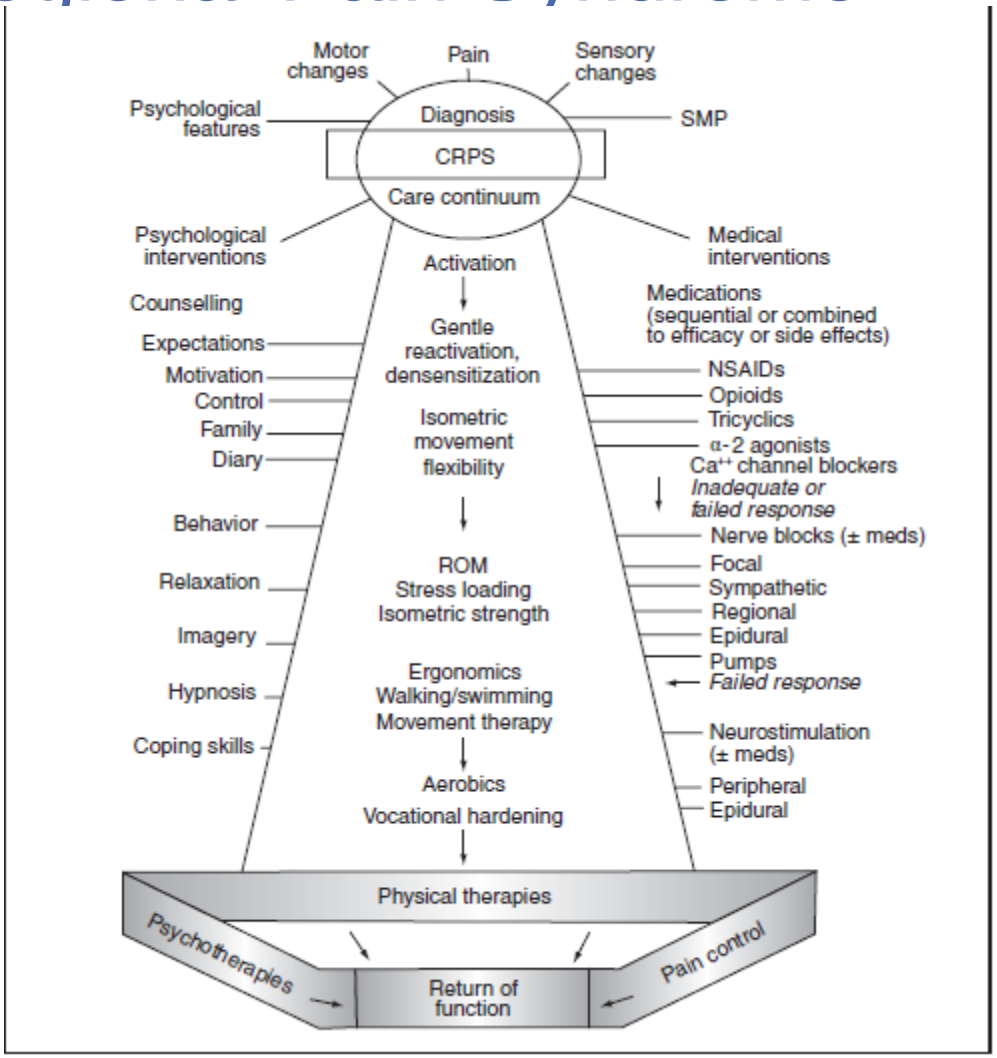
J Am Acad Orthop Surg 2004;12:213-220

Complex Regional Pain Syndrome



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Complex Regional Pain Syndrome

- CRPS has both physical and psychological factors
  - reduced quality of life
  - impaired occupational function
  - anxiety
  - increased depression
  - suicide

Treatment: Non-operative

- Multidisciplinary, early treatment
- Physical therapy
  - goal:
    - Increase function by decreasing the guarding postures and substitute movements
    - range of motion, strength and motor control
    - increasing total daily activity time
    - decrease pain responses to noxious stimuli
    - Inc WBAT
- Exercise program
  - Active, active assisted, passive graded relaxation exercises, gait training, work or diversion activities
  - Some recommend sympathetic blocks or nerve blocks prior to excercise
  - Examples:
    - gentle physiotherapy
    - tactile discrimination training
    - graded motor imagery

Treatment: Non-operative

- Compression:
  - Edema : Jobst , Isotoner, Coban couple w/ mobilization
- Transcutaneous electrical nerve stimulation (TENS)
  - Indications:
    - symptoms present mainly in the distribution of one major peripheral nerve
    - programmable stimulators placed on affected nerves
- Chemical sympathectomy vs. Radiofrequency ablation
  - Indications:
    - acts as another option when physical therapy and less aggressive nonoperative management fails

Treatment: Non-operative

- Medications
  - Inflammation:
    - NSAIDs (e.g., ibuprofen, naproxen, indomethacin)
  - Neuropathic pain and sleep disturbances:
    - Anti-depressants. Exp NE and SSRI (e.g. amitriptyline, doxepin, nortriptyline, trazodone)
    - Anti-convulsants (e.g. carbamazepine, gabapentin)
  - Sympathetically maintained pain (SMP)
    - Clonidine Patch – can cause sedation, hypotension,bradycardia
  - Muscle cramps (spasms and dystonia)
    - Baclofen
    - Klonopin (clonazepam): benzodiazepine drug anxiolytic, anticonvulsant, muscle relaxant, sedative, and hypnotic properties
  - Localized pain related to nerve injury
    - Topical Capsaicin cream

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J Am Acad Orthop Surg 2007;115:281-289

Treatment: Non-operative

- Psychological therapy
  - Goal:
    - help the patient fight against fear of reinjury & worsening pain
    - overcome anxiety, and depression and other psychological co-morbidities
  - Examples:
    - cognitive-behavioral psychotherapy
      - decrease catastrophizing thoughts and beliefs, restructure cognition, goal setting, increase participation in pleasurable activities and stress management
    - group psychotherapy
      - reestablish relation with the society
    - symptom specific psychological treatments (biofeedback & hypnosis)
      - Biofeedback is a useful technique for learning relaxation skills and decreasing pain by increase sense of self-control

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Treatment: Operative

- Manipulation Under Anesthesia
  - indications
    - failed PT
    - forceful manipulation of the extremity should be avoided
- Spinal Cord Stimulation
  - 1990 for the treatment of neuropathic pain
  - mechanism of action is unknown
  - possible mechanisms of actions are activation of nerves in the dorsal column, direct blockage of nociceptive input, and sympathetic inhibition
    - retrospective case study reported excellent pain relief in 8 patients out of 12, with 41-month follow-up
- Intrathecal drug delivery system
  - delivers very small amount of medication to the spinal cord – decreased systemic effects
  - Opioids, Fentanyl, Sufentanil, Bupivicaine, Baclofen, Clonidine, Ziconotide (cone snail toxin)

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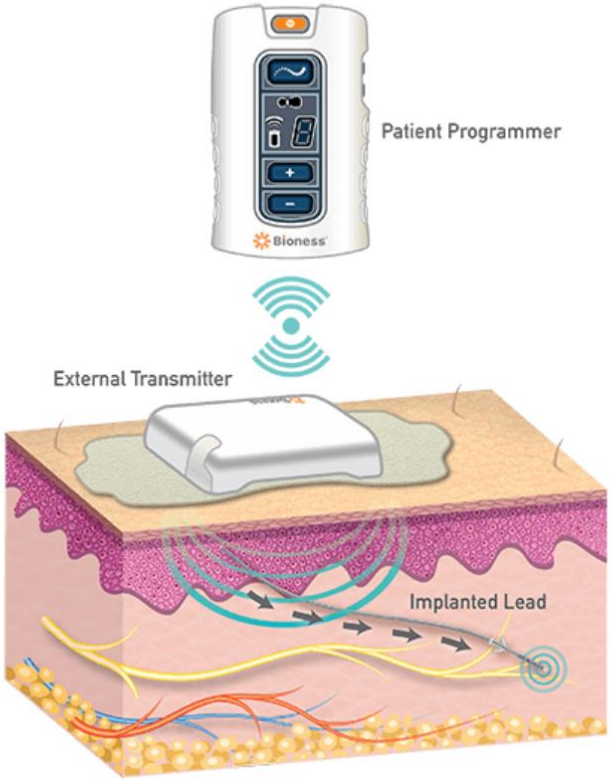
Neurosurgery; 40:503-508,1997



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Treatment: Operative

- Surgical Sympathectomy
  - indications
    - failed nonoperative management, including chemical block vs. relief after a series of non-ablative sympathetic blocks
    - Success varies
    - Can fail:
      - incomplete sympathectomy
      - extensive interconnection of chains of sympathectomy ganglia cause rerouting of sympathetic impulse after removal of short chain of ganglia
      - hypersensitization of adenoreceptors in the sympathectomized area

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Neurosurgery; 40:503-508,1997

Level of Evidence

- A review of the randomized placebo-controlled trials on the treatment of CRPS type 1 identified 26 studies:
  - 18 randomized, placebo-controlled trials and 8 randomized, actively controlled trials
  - Based on this review, there is limited to no evidence for the efficacy of sympathetic blocks (stellate ganglion or regional intravenous sympathetic blocks), free radical scavenging, prednisolone treatment, acupuncture, or manual lymph drainage.
  - Authors have attributed the lack of high-quality studies to detect differences in outcome.

Phantom Limb Pain

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Residual Limb Pain

- Subclassified into neuroma-related pain and phantom limb pain.
  - Neuroma pain is that which is attributable to the formation of symptomatic neuroma.
  - A neuroma is a disorganized collection of axons, Schwann cells, and connective tissue that results as a sequela of a transected peripheral nerve.
- Phantom limb pain refers to the perception of pain in the missing limb such as sensing pain in the foot in the setting of a transtibial amputation.
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- Patients most commonly describe throbbing, burning, and/or clenching, among other sensations.
- Phantom limb pain is separate from the more focal pain associated with neuroma; however, the two are thought to be related to one another.
- Phantom limb sensation and pain remains unknown but is thought to be multifactorial, with a combination of peripheral and central factors including abnormal signaling from injured afferent nerve fibers and eventually changes within the cortical gray matter.

- Risk factors associated with increased phantom limb pain:
  - Include female sex
  - Upper extremity amputation
  - Traumatic amputation
  - Depression and other psychiatric illness
  - Pre-existing pain in the amputated extremity.

Patient Evaluation

- Thorough history and physical exam
- Patients with an existing amputation presenting with pain, the history should focus on the quality and location of the pain, aggravating and alleviating factors, prosthetic type and the amount of use, mobility goals, and any previous treatments.
- The patient should further be evaluated for comorbid conditions such as chronic pain, low back pain, or spine pathology.

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Patient Evaluation

- Special attention should be paid to areas of tenderness on palpation and any provocative symptoms such as a Tinel's sign.
- A Tinel's sign, or shockwave-like symptoms with palpation or percussion along the course of a major peripheral nerve, should raise suspicion for symptomatic neuroma, particularly if the patient confirms that this clinical stimulation replicates their symptoms.
- Identify and treat other causes of residual limb pain such as infection, bony prominences, inadequate padding, poor skin quality, or excessive mobility of the soft tissue envelope.
- Can treat concomitantly at same surgical procedure
- Imaging is simply supportive and not diagnostic. NOT EVERY NEUROMA IS BAD.

Nonoperative Treatment

- Pharmacologic consisting of nonsteroidal anti-inflammatories (NSAIDs), acetaminophen, narcotics, antidepressants, anticonvulsants, nerve modulators, nerve blocks, and local anesthetic patches.
- Targeted steroid injections combined with local anesthetic can provide therapeutic pain relief and valuable diagnostic feedback which can help delineate the primary pain sources in the residual limb.
- Some component of phantom limb and residual limb pain is thought to be related to hyperactivity of N-methyl d -aspartate (NMDA) receptors.
  - Small series have shown the efficacy of sedative-hypnotics such as ketamine given in bolus, which may reset components of this pathway and improve phantom limb sensation and nerve-related residual limb pain
- Psychological treatments for the treatment of phantom limb and nerve-related residual limb pain include mirror therapy, cognitive behavioral therapy, and desensitization therapy.
  - Mirror therapy, effective primarily for phantom limb sensations, uses the patient's intact contralateral limb with well-positioned mirrors and provides visual feedback to the brain, effectively tricking the brain into "seeing" the missing limb.

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Surgical Treatment Options

- Myriad of techniques has been described for the treatment and prevention of postamputation neuroma.
  - More than 150 reported surgical techniques described for the treatment of symptomatic neuroma.
- Meta-analysis data suggest that surgical intervention is superior to nonoperative management with 75% of patients gaining improvement from surgery.
- Several techniques describe the transposition of the terminal nerve end into various target tissues, including vein, bone, and muscle
- Other techniques aim to cap the proximal end of the transected nerve to prevent the regrowth of the sprouting axons. Numerous autogenous and synthetic materials have been described to include synthetic resins, silicone, free vascular graft, and most recently with acellular nerve allograft.

Regenerative Peripheral Nerve Interface(RPNI)

- Small piece of devascularized, denervated muscle tissue is transferred to the affected nerve.
- This provides denervated tissue give the nerve a new target.
- The basis of RPNI was initially to amplify targets and improve transduction for myoelectric prosthetics using implanted electrodes.
- Kubiak: None of the 45 patients who underwent RPNI developed symptomatic neuroma compared with 6/45 (13%) in the control group. Additionally, only 51% of patients who underwent RPNI reported phantom limb pain compared with 91% in the control group.

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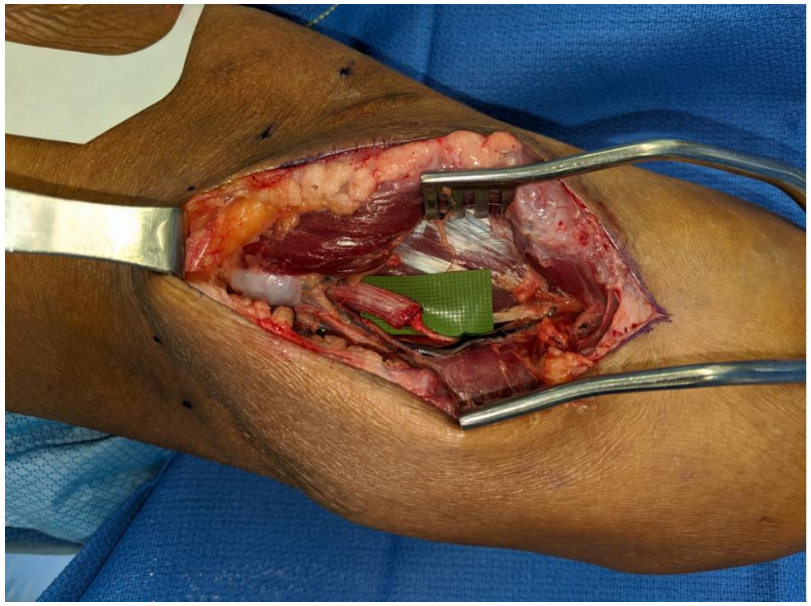
Targeted Muscle Reinnervation(TMR)

- TMR is distinct from RPNI in that instead of transferring these unutilized peripheral nerves to the devitalized muscle, it instead aims to transfer them to expendable, intact motor units
- Initially developed to amplify the number of motor unit targets for myoelectric control in the setting of proximal amputations
- Its benefit in the management of nerve pain was noted after subsequent clinical studies found that patients treated with TMR suffered from less symptomatic neuroma and improved phantom limb pain.



Return To Work

Contents lists available at ScienceDirect

Journal of Hand Therapy

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Scientific/Clinical Article

A systematic review of prognostic factors for return to work following work-related traumatic hand injury

Qiyun Shi MD, MSc [a,b,*], Kathryn Sinden MSc, CK [c], Joy C. MacDermid PT, PhD [a,b,c], David Walton PT, PhD [a], Ruby Grewal MD, MSc [b]

[a] Health & Rehabilitation Sciences, Western University, Elborn College, Room 1014, 1201 Western Road, London, Ontario, Canada N6G 1H1
[b] Hand and Upper Limb Centre Clinical Research Laboratory, St. Joseph's Health Centre, 268 Grosvenor St., London, Ontario, Canada N6A 3A8
[c] School of Rehabilitation Sciences, McMaster University, Hamilton, Ontario, Canada L8S 4L8

- Purpose: To systematically review available evidence to determine which prognostic factors predict return-to-work (RTW) following work-related traumatic hand injuries.
- Methods: We searched Cochrane Central Register of Controlled Trials from 1980 to September 2013 and reference lists of articles. Studies investigating any prognostic factors of RTW after traumatic hand injury were included. Two reviewers performed study selection, assessment of methodological quality and data extraction independently of each other. Identified factors were grouped into conceptual prognostic factor categories.
- Results: We assessed 8 studies, which addressed 11 potential prognostic factors (i.e., sociodemographic factors, occupation, work compensation status, treatment related factors, impairment severity, location of injury, etc.). The quality of the studies was low to moderate. Across all included studies, RTW (original or modified work) occurred in over 60% of individuals by 6 months.

- Conclusion: Impairment severity and lower pre-injury income showed a consistent association with RTW following occupational hand injury, while other factors demonstrated no or variable effects across studies. Additional high-quality studies are warranted toward improving our understanding of the complex factors that mediate RTW following a traumatic work-related hand injury.
- Level of evidence: 2a

The fear–avoidance model to predict return to work after an orthopedic trauma

Johanna Morgounovski[1,*], Philippe Vuistiner[2], Bertrand Léger[2], François Luthi[1]

[1] *Clinique romande de réadaptation, SUVA Care, rééducation de l'appareil locomoteur, Sion, Switzerland*

[2] *Institut de recherche en réadaptation-réinsertion, Sion, Switzerland*

* *Corresponding author.*

E-mail address: j.morgounovski@gmail.com (J. Morgounovski)

- Objective The fear–avoidance model (FAM) is commonly used in musculoskeletal chronic pain. Nevertheless, only few prospective studies have been conducted, especially on return to work (RTW). This study lays the hypothesis that the components of the FAM (catastrophizing, kinesiophobia and depression) can predict RTW 1 year after a vocational rehabilitation for orthopedic trauma patients.
- Material/patients and methods A total of 323 rehab orthopedic trauma inpatients were included. The following predictive factors were analyzed: pain catastrophizing, kinesiophobia, and depressive symptoms. Patients were asked their professional status 1 year after discharge. RTWwas defined as return to the same or accommodated job, full time or part time (at least 50%), over the survey period. Simple and multiple logistic regressions were performed to analyze the relation between predictors and RTW.

- Results A total of 194 patients replied at the 1-year followup. As they were starting rehabilitation, 35.6% had depressive symptoms, 53.2% had a high score of pain catastrophizing and 58.2% had kinesiophobia.
- One year after discharge, 51.3% had returned to work. There were less RTW among the patients with depressive symptoms than among the ones without (30% vs 62%; 0.33 [0.15, 0.76], P = 0.0001).
- There were less RTW among the patients with a high score of pain catastrophizing than among the ones with a low score (40% vs 66%; 0.43 [0.20, 0.92], P < 0.0001). Patients with higher kinesiophobia were less likely to get back to work, but no statistical association was found after controlling for confounding factors (age, gender, pain intensity, work qualification, French as preferred language, and employment contract). In the multivariate model, pain catastrophizing and depressive symptoms were still associated with RTW P < 0.0001).

- Discussion–Conclusion This study suggests the usefulness of screening catastrophizing and depressive symptoms in orthopedic trauma patients during vocational rehabilitation. In clinical practice, this may be achieved through the use of the proposed questionnaires clinical thresholds. Further interventional research is needed to investigate whether targeted interventions on psychological factors would then improve the prognostic.

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Review

A systematic review of early prognostic factors for return to work following acute orthopaedic trauma

Fiona J. Clay *, Stuart V. Newstead, Roderick J. McClure

Monash University, Accident Research Centre, Clayton, Victoria 3800, Australia

- Introduction: Acute orthopaedic trauma is a major contributor to the global burden of disease. This study aims to synthesise and summarise current knowledge concerning prognostic factors for return to work and duration of work disability following acute orthopaedic trauma.
- Methods: A systematic review of prognostic studies was performed. The Medline, Embase, PsychINFO, CINAHL and AMED electronic databases were searched for studies between 1985 and May 2009. Included studies were longitudinal, reported results with multivariate statistical analyses appropriate to prognostic studies, comprised persons employed at the time of the injury, included prognostic factors measured proximal to the injury and focused on upper and lower extremity injuries.

- Results: Searches yielded 980 studies of which 15 met the inclusion criteria and were rated for methodological quality. Analysis focused on the 14 factors considered inmore than one study. There was limited evidence for the role of any factor as a predictor of return to work. There is strong evidence for level of education and blue collar work and moderate evidence for self-efficacy, injury severity and compensation as prognostic factors for the duration of work disability. Significant methodological issues were encountered in the course of the review that limited interpretation of the evidence and the conclusions that could be drawn from the findings.
- Conclusion: People who have sustained acute orthopaedic trauma regardless of severity experience difficulties in returning to work. Due to the lack of factors considered in more than one cohort, the results of this review are inconclusive. The review highlights the need for more prospective studies that are methodologically rigorous, have larger sample sizes and considers a comprehensive range of factors.

Predictors for return to work in patients with median and ulnar nerve injuries *, **, ★

Coen N.P. Bruyns MD, Jean-Bart Jaquet MD, Ton A.R. Schreuders, Sandra Kalmijn MD, PhD, Paul D.L. Kuypers MD, PhD, Steven E.R. Hovius MD, PhD

- **Purpose:** One of the consequences of median and ulnar nerve trauma is delayed return to work. The aim of this study was to determine return to work (RTW) and risk factors for delayed RTW in addition to time off work (TOW). Differences among median, ulnar, and combined median-ulnar nerve injuries were examined. **Method:** In this study 96 patients who were employed at the time of injury and who had undergone surgery for median, ulnar, or combined nerve injuries between 1990 and 1998 were evaluated. The response rate was 84% (n = 81). **Results:** Within 1 year after injury, 59% (n = 48) returned to work. Mean TOW was 31.3 weeks. Return to work after combined nerve injuries was 24% versus after isolated median (80%) and ulnar (59%) nerve injuries. Level of education, type of job, and compliance to hand therapy were predictors for RTW. Furthermore, grip strength loss, tip pinch strength loss, and sensory recovery differed strongly between the RTW and no-RTW population. **Conclusions:** The predictors found in this study increase our understanding of delayed RTW after median and ulnar nerve injury and may be used to optimize postinjury rehabilitation.

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