Rehabilitation after Wrist and Hand Injuries

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Traumatic Lesions

- Soft tissue injuries
- Dislocations
- Fractures

Soft Tissues Injuries

- An indirect or blunt force can lead to injuries of the tendons or the neurovascular bundles.
- **Tendon Injuries of the Wrist and the Hand (Flexors, Extensors)**
- Tendon disruption can be either isolated or it can occur as a component of an associated wrist or hand injury, in which the tendon injury involves the hand bones and the neurovascular bundles

Injuries of the Neurovascular Bundle

- Most often, the neurovascular bundle is injured on the volar aspect of the distal forearm
- Injury by a sharp object (slash or cut)
- During this injury, damage (cut) of the median nerve, ulnar nerve, radial artery or ulnar artery can occur, a finger flexor injury is also common
- Fracture of the distal forearm with subsequent neurovascular bundle compression by a fragment or edema can be another cause of damage

- **Treatment of Tendon and Neurovascular Bundle Injuries**
- Surgical suture of the tendon is the foundation of treatment
- In an isolated injury, ideally a primary tendon repair is performed within 6-12 hours of the injury
- Restoration of skin coverage of the involved tendon is a prerequisite for correct tendon healing, otherwise necrosis develops.
- In associated wrist and hand injuries, the primary treatment involves the nerves, arteries and fracture. Tendon repair can be performed at the same time as fracture stabilization or secondarily
- In a concurrent injury of the tendon and the neurovascular bundle, repair of the nerve, tendon, and at least one digital artery, all at one time, is indicated within 24 hours

Rehabilitation in Tendon Injuries

- Currently, early rehabilitation is administered
- The tendon repair needs to be maintained without tension during rehabilitation
- The Kleinert method of semiactive mobilization – the extremity is stabilized in a splint, but movement in the affected segment is preserved and allowed through a pulley system. In a flexor repair, the segment is passively ranged into flexion and active movement is administered against resistance into extension. The situation is reversed in an extensor repair
- Passive mobilization of the affected segment by continuous passive motion
- Tendon healing time is 4-6 weeks and the tendon can be gradually loaded after this time period. The exercises are performed analytically based on Kenny or by using PNF
- New rehabilitation approaches, the pyramidal system of loading has been beneficial, which is used strictly during rehabilitation of finger flexors. It is a graduated system of exercises comprised of several steps that vary in difficulty
- Modalities include anti-inflammatory therapy ultrasound, lymphatic drainage and hydrotherapy including whirlpool
- Occupational therapy, especially addressing fine motor skills and grasping

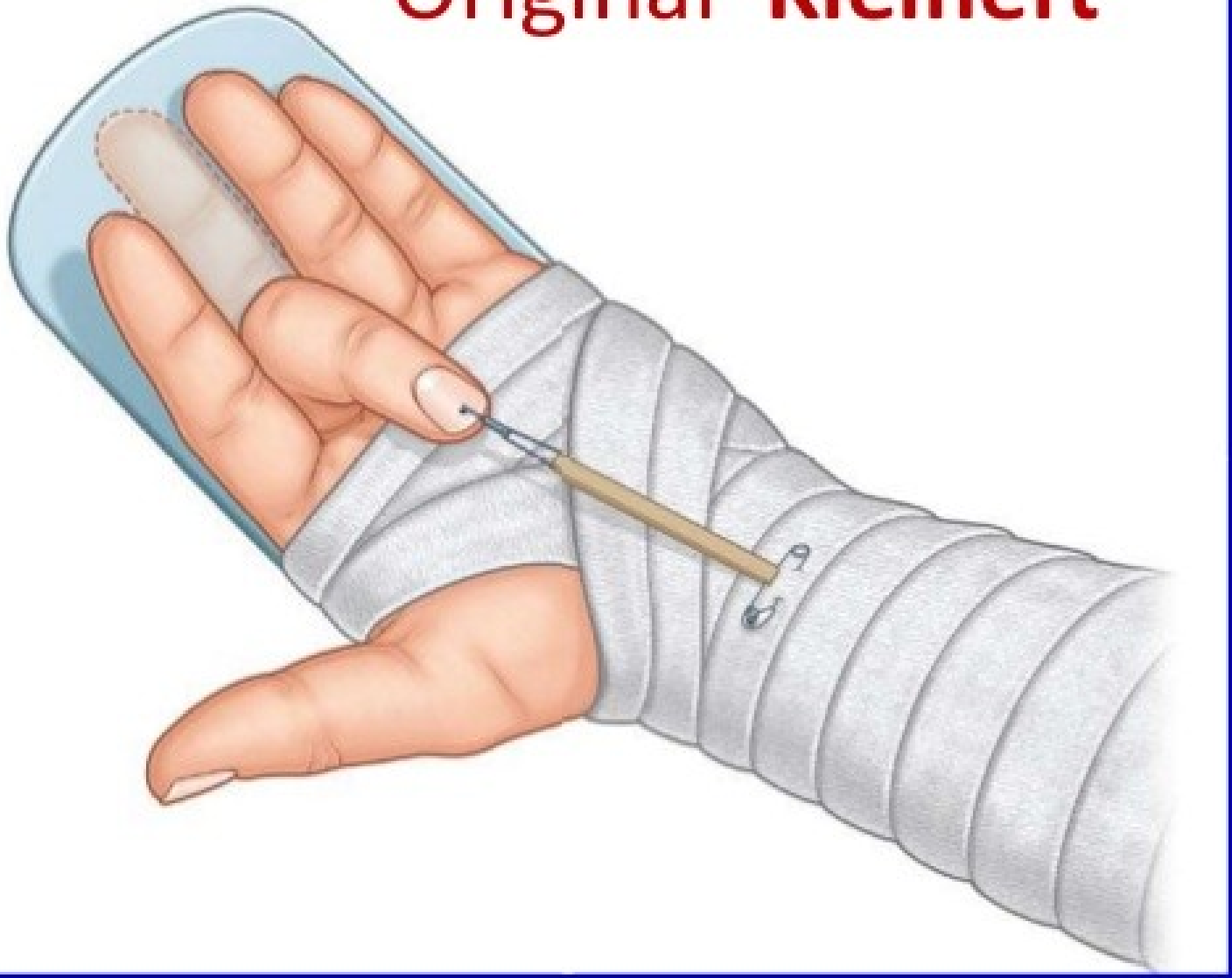
Early Controlled Motion

All Early Controlled Motion should minimize edema and allow IPJ extension to prevent joint contracture.

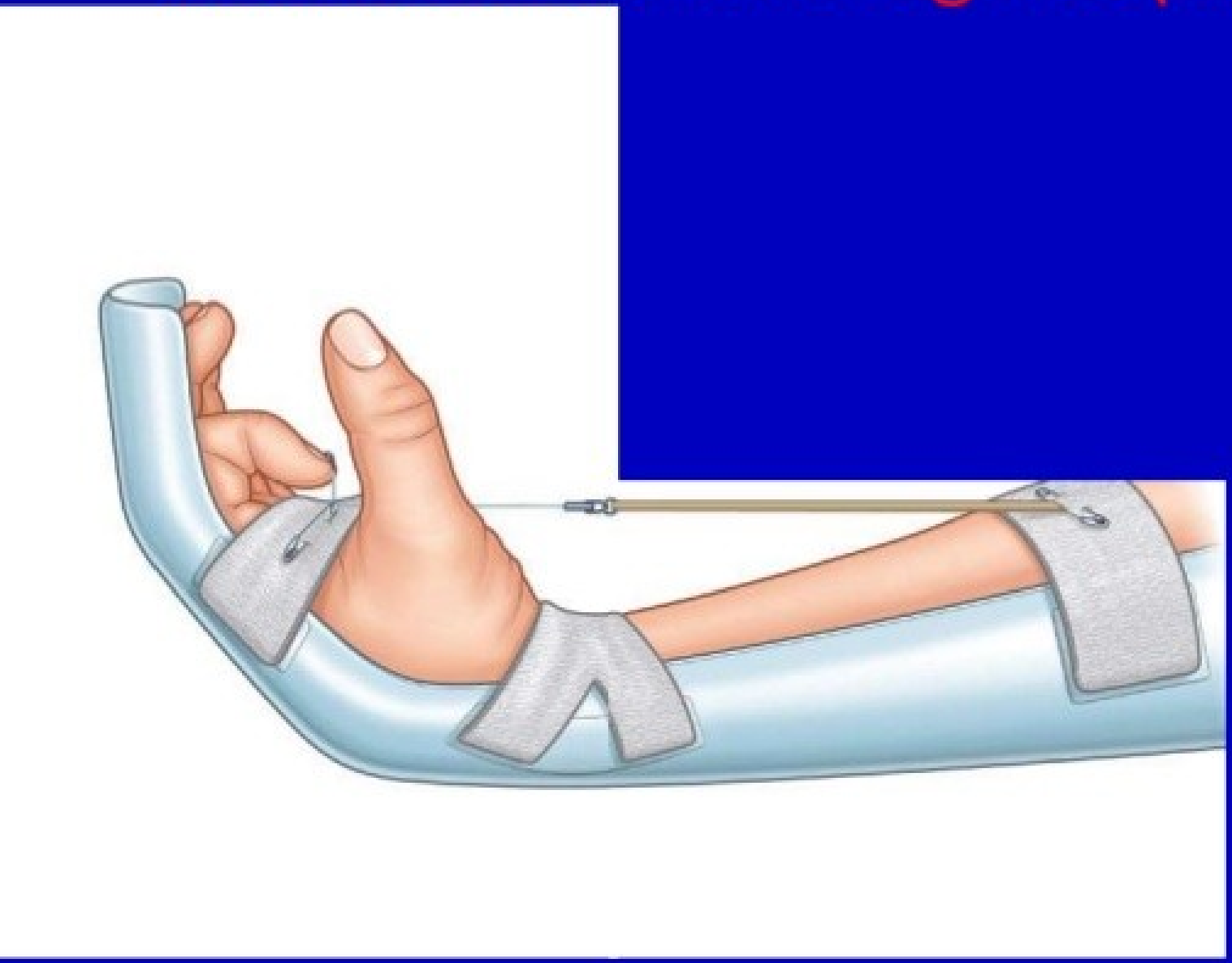
Kleinert & Chow protocol:

- a controlled active extension–passive flexion motion protocol.
- The wrist is palmary flexed with a dorsal protective splint with 30–40° wrist flexion, 50–70° MCP joint flexion, and the IP joints are allowed full extension.

Original **Kleinert**



Modified Kleinert regime (Chow)



- Original Kleinert regime had been changed to Modified Kleinert regime (Chow) due to rubber band traction was found to lead to flexion contractures of the finger.
- Modified Kleinert regime (Chow) differ by:

1. a palmer bar at the level of the MCP joint as a pulley for the rubber bands to create greater flexion of both the PIP and DIP joints.
2. ***the elastic band is detached at night and the fingers are strapped into extension within the splint to minimize the risk of flexion contractures of the fingers.***

- All fingers should be included in the rubber band traction to ensure added FDP protection and to promote better tendon excursion also decrease risk of PIP contracture through more efficient action of EDC.
- mobilization program is begun 1 to 3 days postoperatively.
- The finger to be actively extended within the limitations of the splint. The patient is instructed to perform this exercise 10 times every waking hour.

- At 3 weeks, the splint is altered to further extend the metacarpophalangeal joints with the wrist neutral.
- At 4 weeks, the dorsal splint can be removed, leaving the line/rubber band attached to a wristlet. Wrist exercises are encouraged.
- at 5th week, the rubber band is discontinued; the patient actively flexes without resistance.

Duran–Houser method

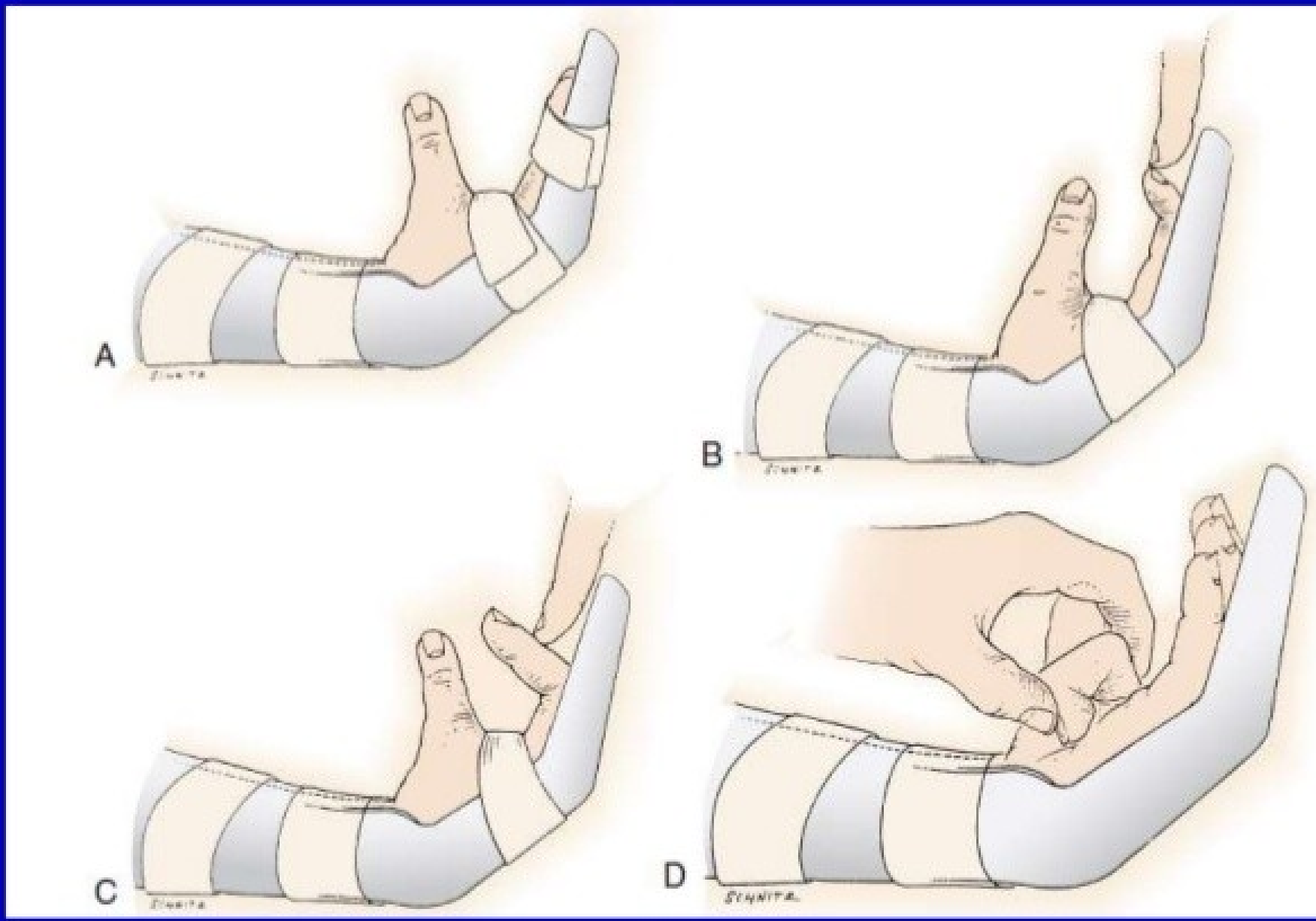
- This is a controlled passive finger flexion protocol without traction of rubber bands.
- dorsal splint is applied with the wrist in 20° flexion, the MCP joint in 50° flexion, and the IP joints are allowed full extension .

Within the first 4-5 weeks, the patients perform:

- 10 passive DIP joint extensions with PIP and MCP joint flexions.
- 10 passive PIP joint extensions with MCP and DIP joint flexions hourly within the splint.

In other word it include:

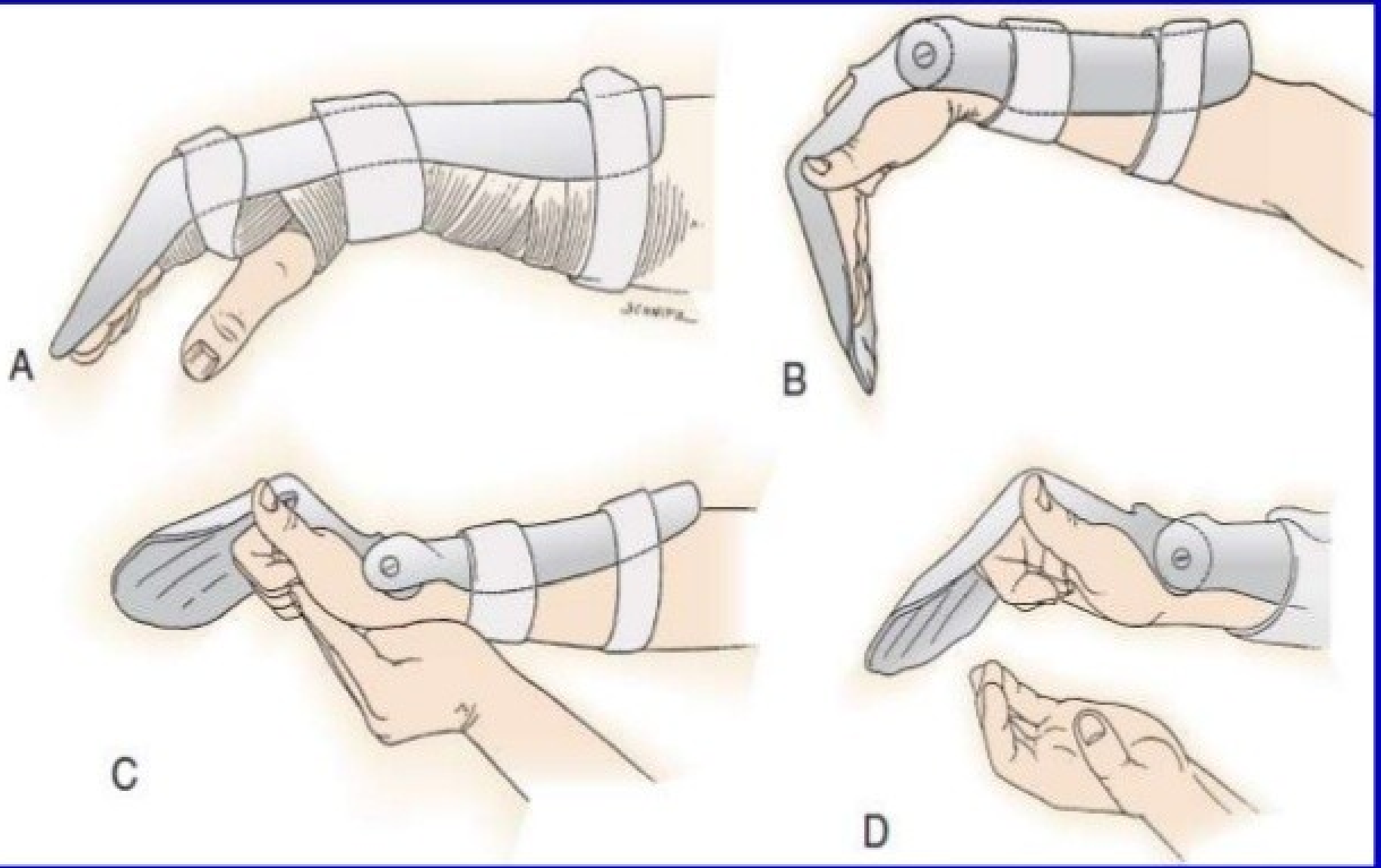
- Full isolated passive flexion of DIP joint.
- Full isolated passive flexion of PIP joint.
- Full passive flexion of MP, PIP, and DIP joints.


A
B
C
D

Early controlled Active Mobilization

- **Strickland indiana protocol(Controlled "place-and-hold"):**
- After removal of the surgical bandage, a traditional dorsal blocking splint that positions the wrist in 20 degrees of palmer flexion, MP joints in 50 degrees of flexion, and IP joints in extension is applied.
- A another tenodesis splint with a wrist hinge is fabricated to allow for full wrist flexion, wrist extension of 30 degrees, and maintenance of MP joint flexion of at least 60 degrees.
- After composite passive digital flexion, the wrist is extended, and passive flexion is maintained. The patient actively maintains digital flexion and holds that position for about 5 seconds. Patients are instructed to use the lightest muscle power necessary to maintain digital flexion.

- This exercise should be repeated fo 25 time per awake hour for 4 weeks.
- After 5 weeks light active flexion with wrist extension commenced.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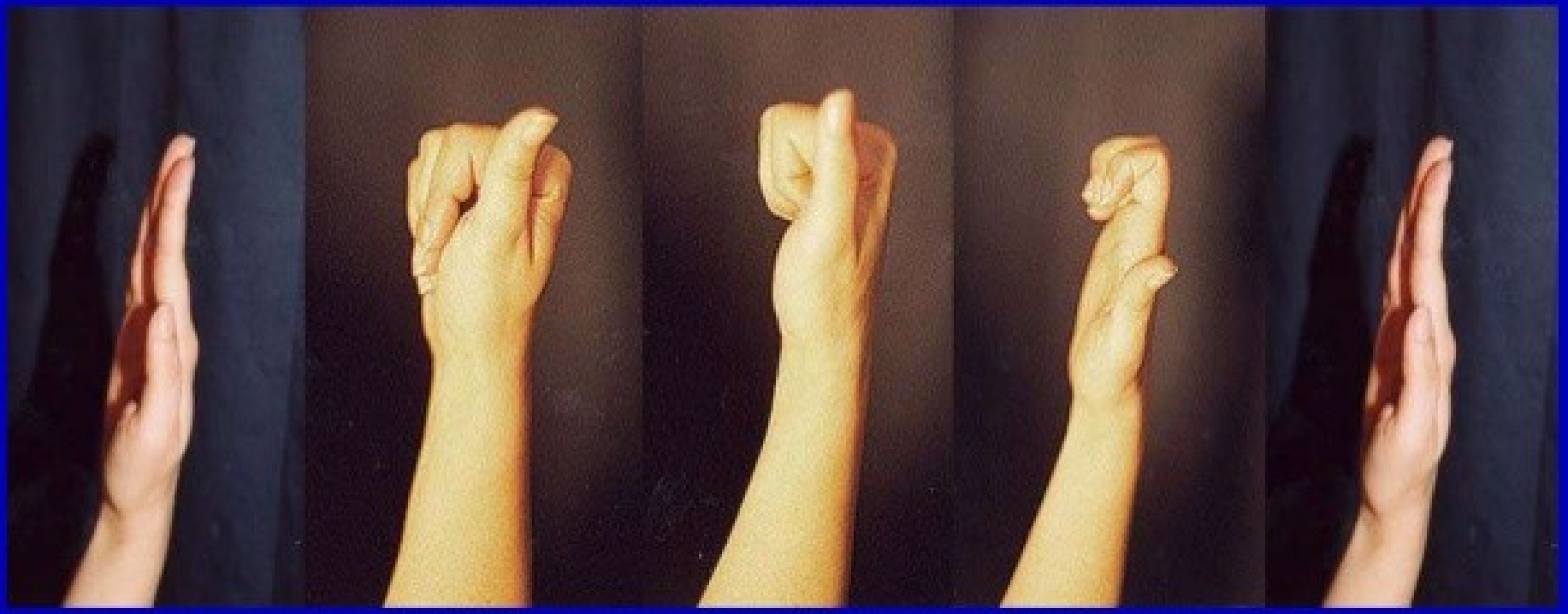
Differential gliding exercises



Resistive exercise

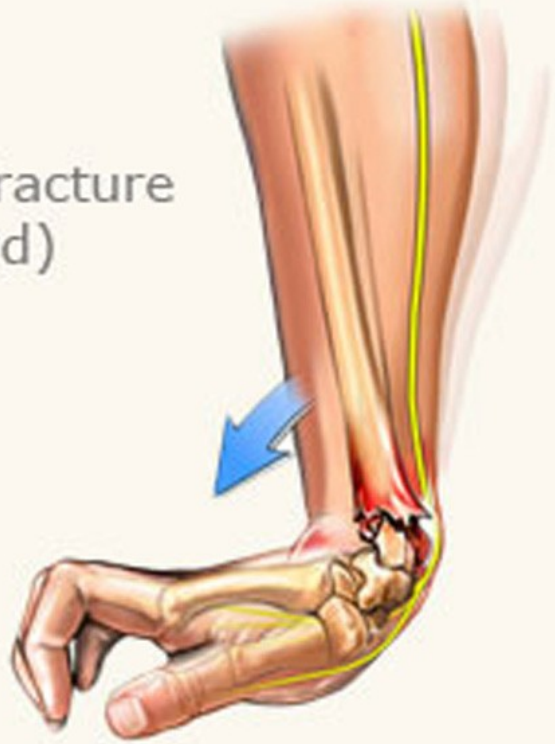
Fractures

- Distal forearm fractures are one of the most common injuries of the skeleton. Next to proximal femoral fractures and compression fractures of the vertebral bodies, they are often associated with the clinical picture of severe osteoporosis
- This group also includes a Colles fracture as a “loco typico” (“typical location”) fracture. It occurs during a fall on the forearm in the long axis when the wrist is in dorsal extension and it is defined as a fracture of the distal radius and dislocation of the peripheral fragment in the dorsal direction
- Smith‘s fracture – during a fall on the wrist in volar flexion – fracture of the distal radius with volar dislocation
- Complex regional pain syndrome (CRPS) formerly known as Sudecks algoneurodystrophy is the most common complication of distal forearm fractures

Coles Fracture

ORIF

Colle's Fracture
(Outward)



Smith's Fracture
(Inward)

- **Treatment of Dislocations and Fractures of the Wrist and Fingers**
- Following surgical treatment, repositioning and stabilization of a displaced fracture, a splint or a brace is applied to immobilize the affected segment
- The immobilization period is usually 2-6 weeks and the length of immobilization is determined by the treating orthopedist or a traumatologist based on radiological findings and clinical assessment

Rehabilitation in Dislocations and Fractures

- Even during immobilization, modalities can be applied to accelerate the healing process. Pulsed magnetic field and distant electrotherapy are most commonly applied
- Physical therapy treatment is initiated following the immobilization period. The goal of therapy includes range of motion restoration in the affected segment while maintaining its stability
- Occupational therapy is an important component of rehabilitation for wrist and hand injuries - to restore hand function including grasping and fine motor skills

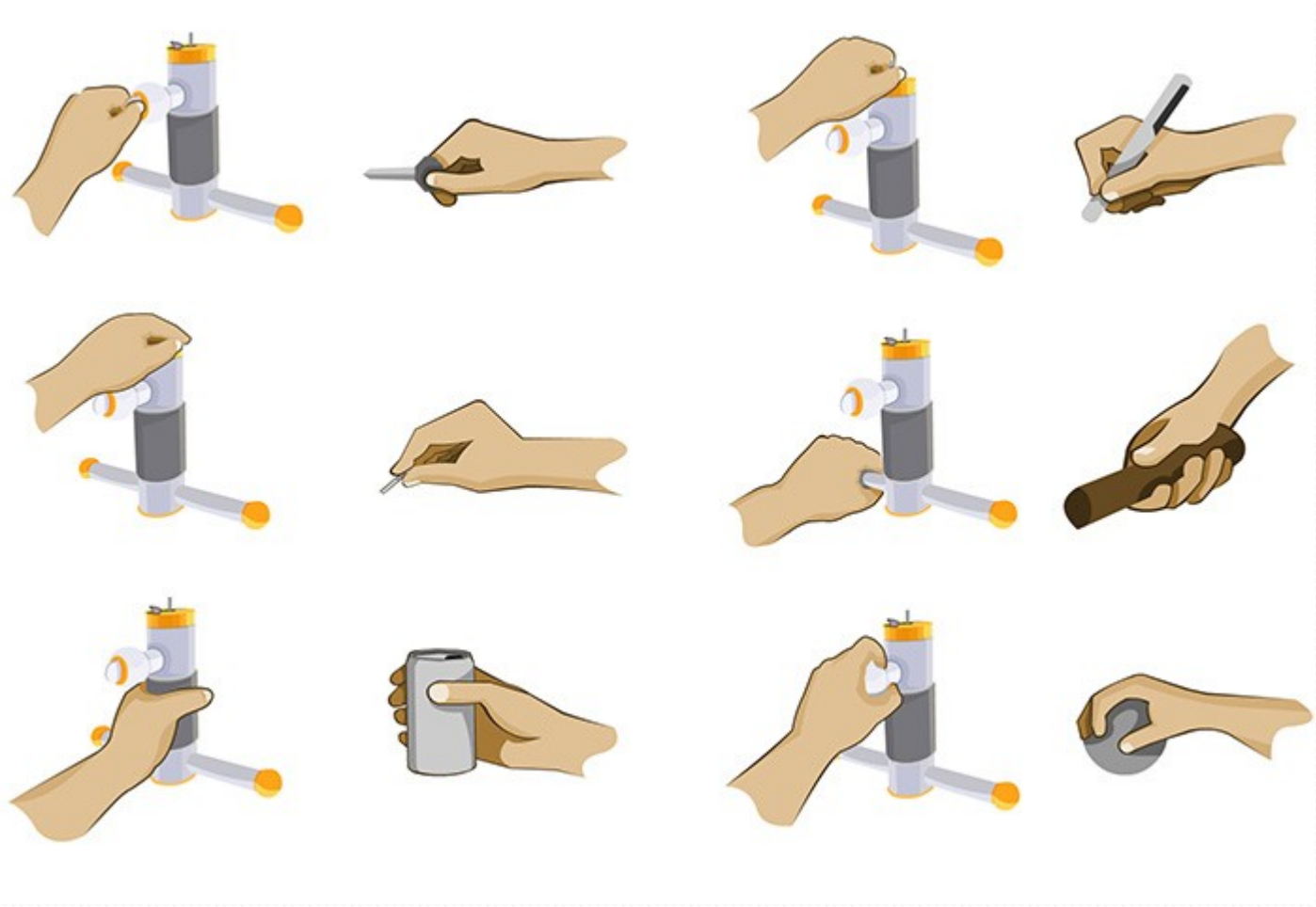
Immobilization Phase

- Cryotherapy (application of ice reduces swelling and pain), forearm elevation
- Modalities – magnet therapy
- Exercises non-immobilizated parts of arm – fingers, elbow, shoulder, cervical spine exercise

Rehabilitative Phase to Restore ROM

- Modalities – cryotherapy, magnet therapy (promotes fracture healing), hydrotherapy – whirpool (reduces swelling a relieves pain)
- Soft tissues mobilization (PIR, balling) – to release contracted muscles, tendons and fascia
- Joint mobilization – to restore joint play
- PROM – passive range of motion exercises, AAROM – active assisted range of motion, AROM – active range of motion
- Resistance exersice to improve muscle strength
- To restore hand function – grasping, fine motor skills

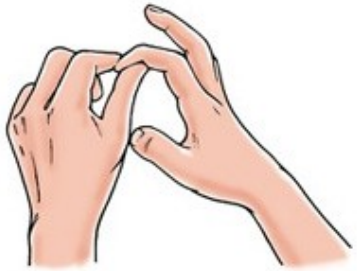
Grasp Patterns



Grasps


Large Diameter
Ring
Medium Wrap
Light Tool
Index Finger Extension
Thumb-Index Finger
Thumb-2 Finger
Thumb-3 Finger
Thumb-4 Finger
Adduction
Power Sphere
Tripod
Precision Disk
Parallel Extension
Extension Type
Lateral Pinch
Lateral Tripod

Mallet Finger (Baseball Finger) Rehabilitation Exercises



Finger passive range of motion

Fist making

Object pick-up

Finger extension

Grip strengthening

Source: http://www.summitmedicalgroup.com

Complex Regional Pain Syndrome (CRPS)

- Complex regional pain syndrome is a term denoted to various pain conditions that occur mainly as a result of an injury
- They are localized and present with most significant clinical changes distal to the initial injury. The clinical changes do not overreach in their intensity or duration from the expected course of initial injury
- They can result in significant deficits in movement function and demonstrate a various progression over time
- CRPS needs to be considered as a manifestation of systemic dysregulation, characterized by an inability of autonomie mechanisms to control and gradually limit anti-regulatory mechanisms whose center is the area of microcirculation
- A stasis with edema and hypoxia develops within the capillary network leading to connective tissue, muscle and bone tissue dystrophy with a severe deficit in joint function that can become irreversible
- Bones show a various degree of porosity, from simple thinning of the trabecular framework to Sudeck osteoporosis

Types of CRPS

- **Type I CRPS (reflex sympathetic dystrophy)**
- Is a syndrome that occurs after the effects of the initial harming injury
- Spontaneous pain or allodynia/hyperalgesia is present that is not limited to the area of an isolated peripheral nerve and it is not proportional to the eliciting injury
- Edema has occurred with deficits in circulation and skin perspiration in the injured area
- Diagnosis of type I CRPS is eliminated by circumstances that can explain the pain intensity and degree of involvement

- **Type II CRPS**
- Is linked to an injury known up until now as causalgia
- It occurs much less often than type I CRPS
- It is a syndrome that occurs with a nerve injury
- Spontaneous pain or allodynia/hyperalgia is present and may not only be limited only to the area of the injured nerve
- Other characteristics of type II CRPS are identical to type I CRPS

Etiology and Pathophysiology of CRPS

- The pain mechanisms found in type I and II CRPS have yet not been explained
- Overview of the most common reasons for CRPS onset:
- **External** - injury (bones, soft tissues, nerves), surgery, burns, frostbite, muscle and ligament overuse, incorrect and painful types of treatment, especially a tight cast or painful rehabilitation
- **Internal** - inflammation (specific, non-specific), myocardial infarction, stroke, tumor congestion, barbiturate intoxication, anti-tuberculosis treatment
- Undoubtedly, psychological changes, especially negative life events and personality traits, including autonomie stigmatization, all contribute to the onset of CRPS

Clinical Presentation of CRPS

- Basic clinical symptoms (spontaneous pain, hyperalgia and allodynia) and other signs, such as circulation deficits, perspiration, edema, trophic changes and movement alterations are typical clinical signs that include the basic clinical criteria for correct diagnosis
- Changes are most often located in the upper extremities and in a large number of cases, they develop as a result of injury and incorrect treatment
- The deficit can be limited to only one extremity, especially its distal aspect
- With disease progression into more advanced states, an ascending myoskeletal reaction occurs, in the context of tissue changes and an overall deficit in statodynamics - shoulder-hand syndrome in the upper extremity, muscle atrophy and thoracic spine scoliosis
- Cases have also been known to include unilateral extremity involvement, in which the deficit initially begins in the upper extremity and subsequent symptom progression affects the lower extremity on the same side, or even the trunk and the head

Clinical Presentation of CRPS

- **Sensory deficit** - pain is the main symptom
- Initially, pain is limited to the affected region, most often an extremity, but can spread until it gradually encompasses a large part of body either unilaterally or even contralaterally
- Pain is often spontaneous, but can be paroxysmal in the sense of paresthesias or dysesthesias
- In nerve involvement (type II CRPS), burning sensation is common and the intensity is variable and often prevents the patient from performing any activity
- Pain worsens with movement, which needs to be remembered especially by the physical therapists
- It worsens with visual, auditory and psychological stimuli (stress), similarly to some other pain syndromes

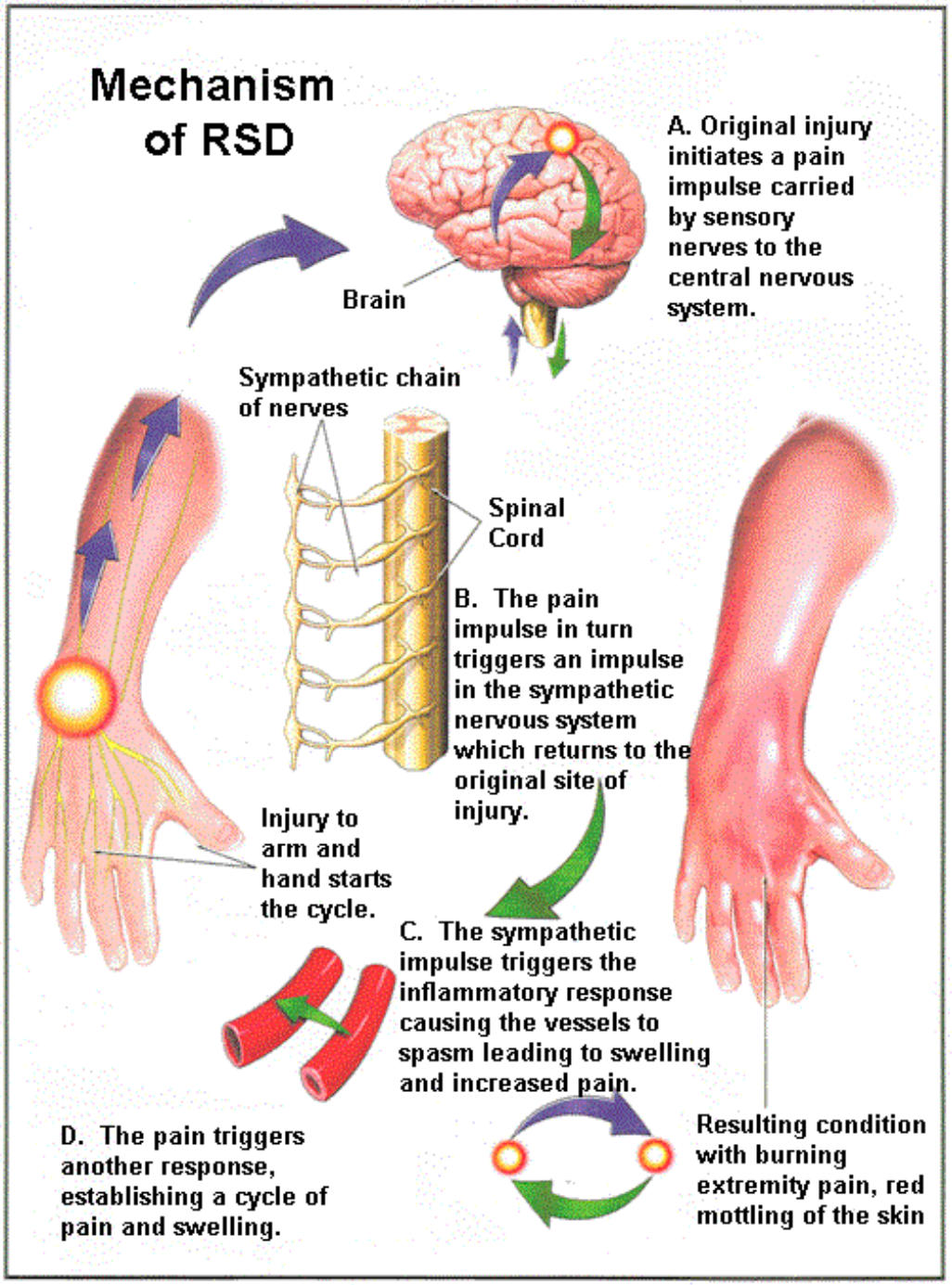
- **Autonomie dysfunction**
- Is manifested as marble-looking skin or its reddening, cyanosis and changes in skin temperature
- It can be present in 75-90% of type I CRPS
- It is apparent that the skin can be either warm from peripheral vasodilation or, in contrast, cold from vasoconstriction
- Pseudomotor anomalies are common (hypo or hyperhidrosis)
- **Trophic deficit**
- Commonly occurs in the later stages, usually weeks or months after the initial injury
- Changes can affect skin, subcutaneous tissue as well as muscles, joints and bones
- Thin skin, rough nails prone to breakage, an increase or decrease in hair growth and involvement of ligaments, aponeuroses, joints and bones

- **Motor deficit**
- Is the most common
- It includes muscle weakness, tremor, dystonia, etc.
- According to some authors, motor deficits are an integral component of CRPS
- Decreased muscle strength is found in nearly all patients
- The fact that range of motion and muscle strength are limited mainly by pain are clinically valuable signs of CRPS

Stages of CRPS

- If CRPS is not correctly treated, there is no exception that the symptoms will persist for many months or years in the form of one of the three clinical stages, in which the course of the disease is commonly classified as follows :
- **Acute stage** - increased circulation, edema
- **Dystrophic stage** - decreased circulation, increased edema, range of motion restrictions, 3-6 months after the initial injury, can still be reserved
- **Atrophy stage** - muscle and connective tissue involvement, irreversible

Symptom	Characteristics
Pain	Dull, deep, poorly localized, intense, persistent. It increases with activity. Non-anatomical location!
Weakness	Non-anatomical distribution! Difficult to assess, performance fluctuates, limited more by pain than muscle performance. Grows with time.
Mobility	Passive and active range of motion are limited equally, limited by pain in the acute stage and by contractures in chronic stage.
Sensation	Hyperesthesia of all senses (non-dissociated), occurs in dystrophic and atrophic stage, usually feeble
Trophic changes	Livedo reticularis, changes in all tissues, bone remodeling (radiology, scintigraphy), development of skin changes form hyperproductive phenomena to atrophy with loss of appendages
Perspiration disturbances	Highly correlates with prognosis, however; requires quantitative methods of assessment, which are not available in the Czech Republic.They are graded as plus or minus.
Vasomotor activity	Gross changes in regulation of vascular motility and permeability of the vessel wall.
Edema	Soft or lymphostatic edema in acute and later dystrophic phase.


Mechanism of RSD
A. Original injury initiates a pain impulse carried by sensory nerves to the central nervous system.
Brain
Sympathetic chain of nerves
Spinal Cord
B. The pain impulse in turn triggers an impulse in the sympathetic nervous system which returns to the original site of injury.
Injury to arm and hand starts the cycle.
C. The sympathetic impulse triggers the inflammatory response causing the vessels to spasm leading to swelling and increased pain.
D. The pain triggers another response, establishing a cycle of pain and swelling.
Resulting condition with burning extremity pain, red mottling of the skin

Treatment

- The diagnosis is often incorrectly established and the condition classified under a different clinical unit or set of symptoms
- Diagnosis and treatment require a multidisciplinary approach if the whole group of structures is affected (soft tissues, bones, joints, central or peripheral nervous system)
- The patient can also be incorrectly treated because they are assessed from only a limited perspective within a certain specialty. It is not an exception, that in the initial phases of the disease, the affected segment is immobilized because of an incorrect diagnosis
- A whole spectrum of treatment approaches is used to treat CRPS. They are mainly aimed at pain and edema control, improving the vasomotor state and restoration of restricted mobility
- The fundamental treatment strategy in CRPS includes restoring night sleep, decreasing pain, decreasing microcirculation deficit, influencing localized changes and restoring restricted mobility

Rehabilitation

- Treatment rehabilitation plays an important role in the treatment of this syndrome
- Pain-free techniques and methods are the main requirement for treatment
- Individual approaches and methods are selected based on the stage of CRPS
- **In the acute stage** - isometric exercises, passive exercises are contraindicated
- In the acute stage, the patient does not tolerate any stimuli in the affected segment
- Locally, non-contact and aperceptive (patient does not feel the procedure) procedures – distant electrotherapy (DE, on VAS 07 equipment analgesic currents L1-L5) and low frequency pulsed magnetic therapy
- Soft tissue mobilization techniques, balling
- Vasopneumatic therapy
- Priessnitzs wraps
- Heat procedures are contraindicated

Rehabilitation

- **In dystrophic and atrophy stages**, circulation needs to be increased and the development of dystrophic changes prevented
- Early detection of the primary signs and initiation of adequate treatment can prevent irreversible dystrophic changes (third stage) and chronic pain
- Modalities -distant electrotherapy and magnetic therapy to promote bone and soft tissues healing
- Vasopneumatic therapy is indicated to improve extremity blood circulation and lymphatic drainage
- Ultrasound - in the case of chronic edema
- When blood vessel reactibility normalizes, heat hydrotherapy procedures (whirlpol) or dry heat can be initiated and applied locally
- A consensual reaction of the vascular system can also be used, in which the application of a warm procedure to an uninvolved area on the extremity leads to vasodilation and improved perfusion on the affected extremity
- Vibration exercises, active exercise of the affected area including large-scale exercises, in which the affected area is included into global movement (yoga and tai-chi), Vojtas therapy

Rehabilitation

- In all phases - minimizing skin sensitivity
- Stroking and similar techniques, balling
- Mobilization techniques are combined with active exercises
- Application of microcurrents was observed to provide beneficial effects
- Other modality options - TENS, ultrasound and magnetic therapy
- Psychological or psychotherapeutic intervention is often needed because, based on clinical experiences, CRPS most often occurs in neuroautonomically more labile individuals
- Pharmacologic treatments