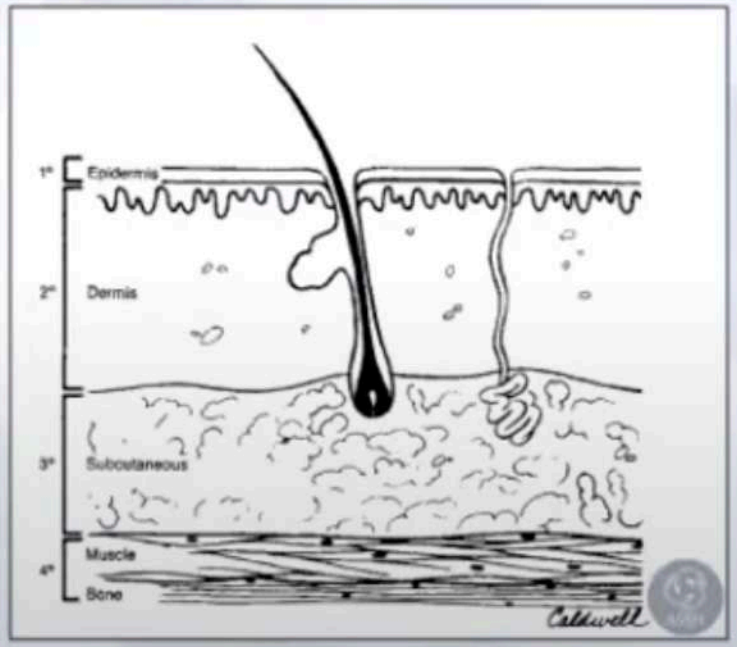
CRUCIAL ELEMENTS in HAND SURGERY 2

- Introduction
  - Estimated 2 million burns/yr. in US
  - 500K burns treated in the ER
  - 70K burn hospital admissions
  - Mortality highest in the age groups: 2-4 yrs. and 17-25 yrs.
  - Deep hand burns are a criteria for referral to burn center or hand specialist

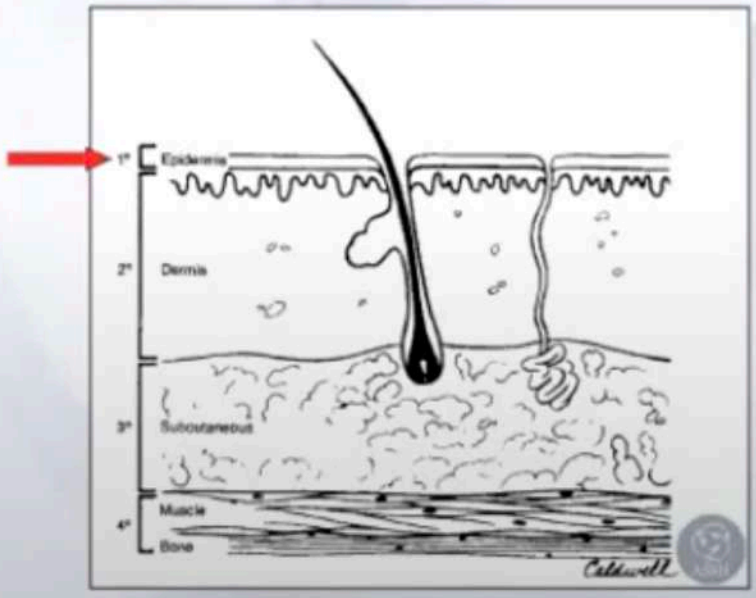
Burns are classified by the depth of skin injury



Essentials of Hand Surgery 2002

CRUCIAL ELEMENTS in HAND SURGERY 2

- First Degree: Epidermal injury only
- Clinically characterized by edema and erythema



CRUCIAL ELEMENTS in HAND SURGERY 2

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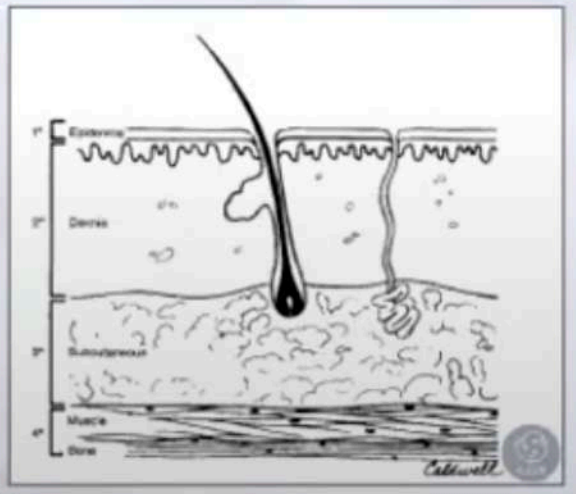
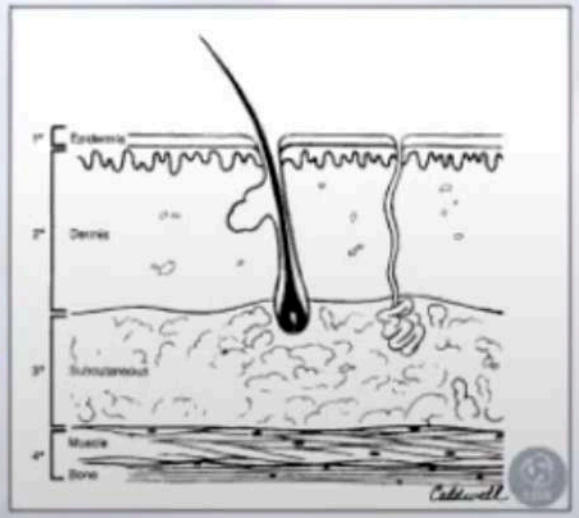
- Second Degree: Injury to epidermal +/- dermal layers
- Clinically characterized by painful blisters
- Skin is repopulated by viable germinal cells in follicles



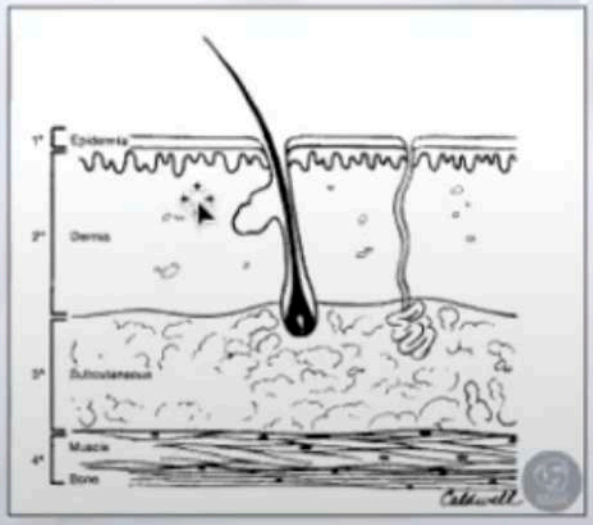
CRUCIAL ELEMENTS in HAND SURGERY 2

- Third Degree: Entire Dermal layer and subdermal fat injured
- Clinically produces dry, inelastic, and waxy appearing scar



CRUCIAL ELEMENTS in HAND SURGERY 2

- Fourth Degree: Dermis + Deep tissue
- Clinically produces injury to all skin layers, and includes tendon, nerve, bone, and joint



CRUCIAL ELEMENTS in HAND SURGERY 2

- Thermal burns
  - Heat
  - Edema
  - Ischemia
  - Infection

- Thermal burns
  - Extent and depth of the injury is proportional to intensity and duration of heat applied

CRUCIAL ELEMENTS in HAND SURGERY 2

- Edema
  - Inflammatory phase
  - Hand edema produces joint fibrosis and contractures

CRUCIAL ELEMENTS in HAND SURGERY 2

- Ischemia - Systemic factors:
  - Hypovolemia from evaporation and increased capillary permeability
  - Fluid resusitation is required for significant burns
    - Parkland formula: LR 4cc/kg/%Burn
  - Local factors:
    - Unyielding eschar/compartment
    - Ischemia leads to loss of injured/viable tissue

CRUCIAL ELEMENTS in HAND SURGERY 2

- Infection
  - Multiple factors contribute to development of the infection
  - Systemic factors:
    - Impaired immune response
  - Local factors:
    - As bacterial counts increase, invasion of bacteria into the dermis occurs

- Infection
  - Can convert burns from a partial to full thickness injury
  - Prior to antibiotic use, Streptococcus species was most common organism. Still seen with burn cellulitis.
  - Pseudomonas species is most common cause of systemic sepsis

CRUCIAL ELEMENTS in HAND SURGERY 2

- Management - For significant burns consider transfer to a burn center
  - >25% body surface area (BSA)
  - 20% BSA in children/elderly
  - High voltage burns
  - Inhalation injuries

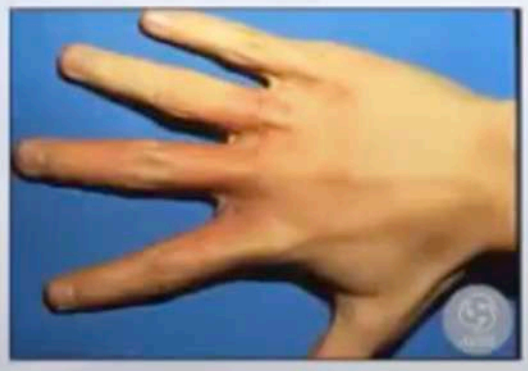
CRUCIAL ELEMENTS in HAND SURGERY 2

- Objectives - Prevention of
  - Edema
  - Contractures due to poor positioning of the hand and prolonged immobilization
  - Infection
  - Preserve viable tissues

- Treatment - First degree burns
  - Symptomatic treatment
    - Mild analgesics / NSAIDs
  - Local wound care
    - Daily cleansing
    - Topical antibiotics (e.g. silver sulfadiazine) if needed
  - Elevation
  - OT
    - Splints in functional position
    - Early range of motion

CRUCIAL ELEMENTS in HAND SURGERY 2

- Treatment – Second degree burns
  - Similar to first degree
  - Leave blisters intact. If debrided, cover with an occlusive dressing
  - Compression garment after wound epithelialization

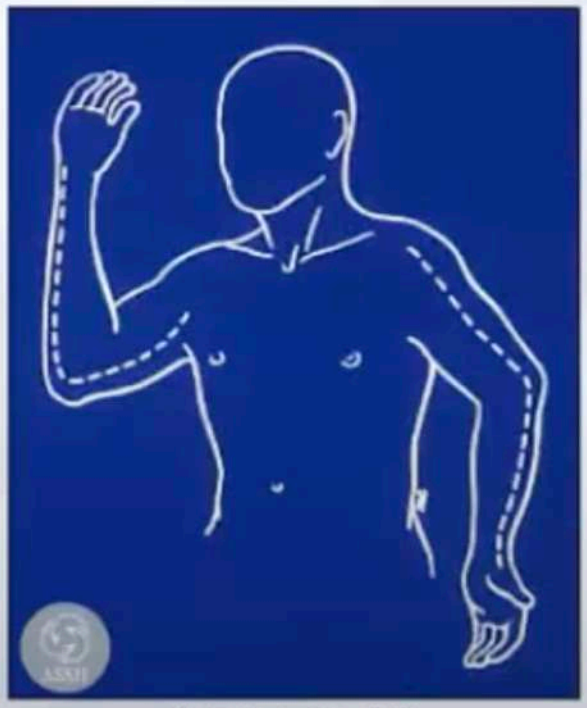


- Treatment – Third degree burns
  - Early tangential skin excision and meshed split thickness skin grafting (within 7 days)

- Treatment – Fourth degree burns
  - Skin grafts not adequate for exposed deep structures
  - Treatment options:
    - Amputation
    - Flap coverage with salvage procedures

CRUCIAL ELEMENTS in HAND SURGERY 2

- Escharotomy
  - Indications:
    - Poor tissue perfusion
    - Threat to perfusion after volume resusitation
    - Circumferential burns
  - Use mid-axial incisions



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- Digital escharotomy
  - Use mid-axial incisions
    - Index, long: ulnar incision
    - Ring: radial or ulnar
    - Little: radial incision
  - Leave wounds open
  - Consider carpal tunnel release
  - Consider intrinsic muscle release

Regional Review Course 1998

CRUCIAL ELEMENTS in HAND SURGERY 2

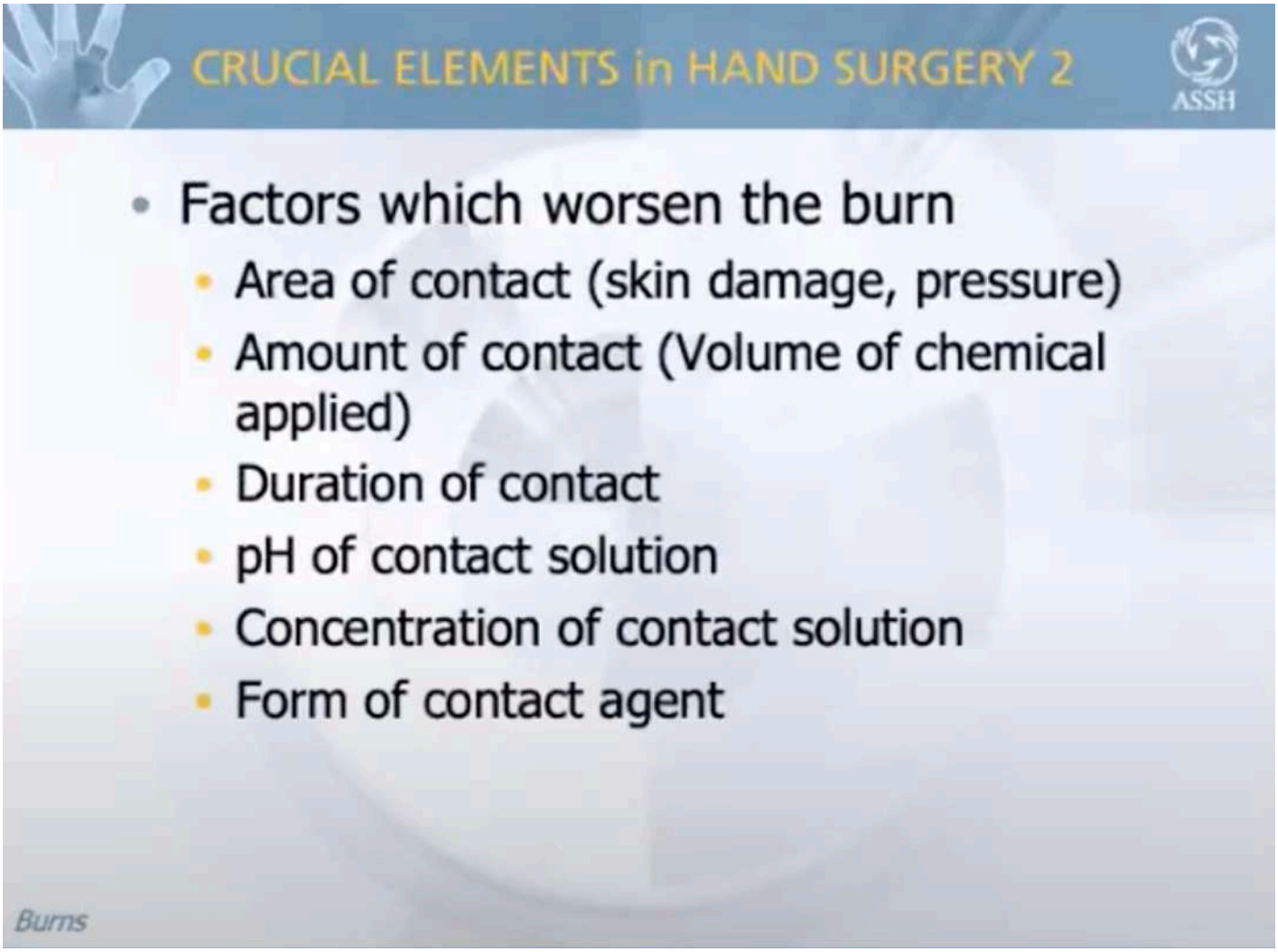
- Antibiotics
  - Intravenous or oral antibiotics should cover skin flora for initial treatment
  - Topical antibiotics (silver sulfadiazine) for prevention of infection
  - Topical application of mafenide acetate penetrates through eschar and may be effective against a wider variety of organisms

CRUCIAL ELEMENTS in HAND SURGERY 2

- Wound closure
  - First degree and superficial second degree burns:
    - Local wound care only
  - Deep 2nd degree burns:
    - Controversial
    - Functional results worse than superficial 2nd degree burns
    - Consider excision and skin grafting if hand burns will take 14 days to "close"

CRUCIAL ELEMENTS in HAND SURGERY 2

- Chemical burns - Types of burns
  - Acid
  - Base
  - Acute vs chronic
  - Short acting vs long acting
  - Superficial vs deep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• Factors which worsen the burn
• Area of contact (skin damage, pressure)
• Amount of contact (Volume of chemical applied)
• Duration of contact
• pH of contact solution
• Concentration of contact solution
• Form of contact agent
Burns

CRUCIAL ELEMENTS in HAND SURGERY 2

- Acids (pH < 7)
  - Proton donors (H^+)
  - Lower number on logarithmic scale is more powerful
  - Necrosis by protein denaturation
  - Forms eschar which limits penetration

Acids (pH < 7)

- Sulfuric acid (#1)
- Hydrofluoric acid
- Hydrochloric acid
- Phosphoric acid
- Nitric acid
- Formic acid
- Acetic acid
- Trichloroacetic acid
- Chloroacetic acid
- Phenol (carbolic acid)
- Cresols

- Where are these acids?
  - Batteries: sulfuric acid, lithium
  - Toilet bowl cleaners/cement removers: muriatic acid
  - Pool cleaner: hydrochloric acid
  - Rust removers: hydrofluoric acid, chromic acid
  - Chemical Peels: phenol

CRUCIAL ELEMENTS in HAND SURGERY 2

- Bases (pH > 7)
  - Proton acceptor (OH^-)
  - Higher pH is stronger on logarithmic scale
  - Liquefaction necrosis
  - Protein denaturation
  - Lipid saponification (exothermic=heat producing)
  - Eschar can not form and base penetrates deeper than acid (continuous action)

- Bases (pH > 7)
  - Ammonia
  - Sodium/calcium hypchlorite
  - Sodium/potassium hydroxide
  - Calcium hydroxide / oxide
  - Silicates,Phosphates
  - Lithium hydride

- Where are these bases?
  - Drain cleaners: sodium hypochlorite (lye), sodium hydroxide
  - Tile cleaners: Ammonium chloride
  - Cement: lye (calcium oxide), alkali
  - Petroleum solvents (organics)
  - Bleaches/household cleaners: oxidizers
  - Air bag deployment: alkali

CRUCIAL ELEMENTS in HAND SURGERY 2

- Special Categories
  - Oxidants
    - Bleaches, peroxides, chromates, manganates
    - Neutralize with milk/egg white/starch before water irrigation
  - Reduction Reactions
    - Binds free electrons and thus denatures proteins
    - Neutralize first with soda lime, soap, magnesium before water irrigation


CRUCIAL ELEMENTS in HAND SURGERY 2
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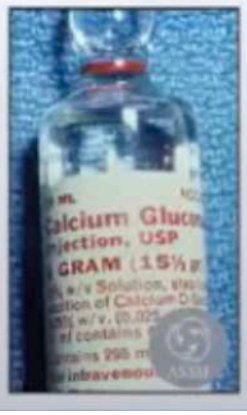
Special Categories
Corrosives
White phosphorus (military), metals, aqueous ammonia, phenol
Remove particles, Copper sulfate solution
Desiccants (sulfuric acid, muriatic acid)
Dehydrate tissues
Exothermic: heat producing
Neutralize with lime water/soap/magnesium oxide
Burns

CRUCIAL ELEMENTS in HAND SURGERY 2

- Special Categories
  - Vesicants
    - Chemical warfare (phosgene, mustards, etc)
      - Blisters, edema, ischemic necrosis
      - Special antidotes
    - Chemotherapy agents
  - Protoplasmic Proteins (hydrofluoric acid, acetic acid, tungstic acid, tannic acid)
    - Form salts and bind proteins/calcium/or ions

CRUCIAL ELEMENTS in HAND SURGERY 2

- Special Chemicals: Hydrofluoric Acid
  - After initial lavage for 30 minutes to treat the H^+ ion, treat fluoride ion
  - 10% Calcium gluconate gel topically
    - May need to remove nails to get contact
    - May combine with 50% DMSO (dimethyl sulphoxide)
  - Consider injection (not with digits)
  - Consider intra-arterial injection




CRUCIAL ELEMENTS in HAND SURGERY 2
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Electrical burns
Pathophysiology
Severity of an electrical injury depends upon:
Voltage
Amperage
Resistance
Type of current
Duration of contact
Tissue resistance:
bone>fat>tendon>skin>muscle>vessel>nerve
Path of current:
Low voltage follows least resistance
High voltage direct flow
Burns

- Systemic Injuries
  - Cardiac arrhythmias
  - Renal failure
  - Sepsis
  - Peripheral nervous system injury

CRUCIAL ELEMENTS in HAND SURGERY 2

ASSH

- Electrical burns – Evaluation
  - Extent of necrosis hard to assess
  - Red, swollen extremity
  - Entry and exit wounds
  - Skeletal injury possible secondary to a fall or being thrown
  - Compartment syndrome
    - Low threshold for fasciotomy

- Electrical Burns – Treatment
  - Fasciotomy:
    - Within 4 to 6 hours
    - Nerve decompression as needed
  - Debridement of devitalized tissues
  - Second look procedure
    - 48-72 hours
    - Expect additional necrosis from vascular thrombosis
  - Definitive treatment:
    - Amputation and/or flap coverage

- References

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  - Seyb ST et al. A Study to determine the efficacy of Treatments for Hydrofluoric burns, J Burn Care Rehab 16(3:1): 253-257.