THERMAL INJURIES
Exposure to Heat

Local Effects

- **Burns** - Due to application of dry heat
- **Scalds** - Due to application of moist heat
Definition: BURNS

- Injuries produced by application of dry heat by flame, radiant heat or some heated solid substance like metal or glass

- Burn Injuries produced by
  - Friction
  - Lightening
  - Electricity
  - UV and Infrared rays
  - X rays
  - Corrosives
X ray burns

- Mere redness to dermatitis
- Shedding of hair and epidermis
- Pigmentation of surrounding skin
- Fingernails show degenerative changes and wart-like growths
- Severe exposure — vesicles or pustules — form sloughing ulcers — slowly heal
- Radial shape scar with surrounding pigmentation
Chemical rays and Corrosives

- **UV rays**
  - Undue exposure to Sun
  - Erythema of exposed part
  - Vesication

- **Infrared rays**
  - Necrosis and toughening of tissue exposed

- **Corrosives**
  - Distinctive stains
  - Eschars – moist and soft, ready slough away
  - No red line of demarction
  - Hair are not scorched
  - No vesication
Classification...

- Dupuytrens Classification:
  - First degree - Erythema
  - Second degree - Vesication with blister formation
  - Third degree - Destruction of superficial skin
  - Forth degree - Destruction of whole skin (dermis)
  - Fifth degree - Destruction of fascia and muscles
  - Sixth degree - Charring involving vessels, nerve, bones
Wilson’s Classification

- Epidermal (Dupuytren’s 1st and 2nd degree)
- Dermo-epidermal (Dupuytren’s 3rd and 4th degree)
- Deep (Dupuytren’s 5th and 6th degree)

Hebra’s Classification:

- Three degrees (Same as Wilson’s)
Patho-pysiology

- Local tissue response
- Systemic response to burn injury.

**Local tissue response**
- Damage to skin from thermal injury cause tissue changes know as zone of injury.
- If the heat is severe, a *zone of coagulation* is formed, in this area protein has been coagulated and the damage is irreversible.
Local tissue response

- Therefore, blood vessels are damaged, resulting in ↓perfusion.

Zone of Stasis

- Poor blood flow and tissue edema will cause risk for death over a few hours or days.
- Further necrosis can happen, because other factors e.g. dehydration and infection.
- Due to these wound have to be clean/care, hydration and prevention of infection are essential to limit further destruction.
Local tissue response

- **Zone of hyperemia** or inflammation is at the outer edge of the burn.
- Here blood flow is ↑ because of vasodilation.
- Vasodilation because of the release of vasoactive substances.
- ↑ blood flow brings leukocytes and nutrients to promote wound healing.
Facts to be established......

- Identification of the person
- Whether victim was alive at time of fire
- The cause of death
- The manner of death
- Any other factor that contributed to either cause of fire or death of the person, e.g. drugs or alcohol
Effects of burns......

- Intensity of heat applied
  - $44^\circ C$ for 5-6 hours
  - $65^\circ C$ for 2 sec

- Duration of exposure

- Extent of Total Burnt Surface Area
  - (WALLACE’S RULE OF NINE)

- Site of burns
  - Burns on head & neck, trunk or anterior abdominal wall are more dangerous

- Age - Children are more susceptible

- Sex - Female are more susceptible
RULE OF NINE

- 9% each
  - Head and neck
  - Each for upper limb
  - Front of chest
  - Back of chest
  - Front of abdomen
  - Back of chest
  - Front of lower limb
  - Back of lower limb
- 1% for perineum
Lund and Browder

- More precise method of estimating
- Recognizes that the percentage of BSA of various anatomic parts.
- By dividing the body into very small areas and providing an estimate of proportion of BSA accounted for by such body parts
- Includes, a table indicating the adjustment for different ages
- Head and trunk represent larger proportions of body surface in children.
<table>
<thead>
<tr>
<th>AREA</th>
<th>AGE 10</th>
<th>15</th>
<th>ADULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 1/2 OF HEAD</td>
<td>5 1/2</td>
<td>4 1/2</td>
<td>3 1/2</td>
</tr>
<tr>
<td>B 1/2 OF ONE THIGH</td>
<td>4 1/4</td>
<td>4 1/2</td>
<td>4 3/4</td>
</tr>
<tr>
<td>C 1/2 OF ONE LEG</td>
<td>3</td>
<td>3 1/4</td>
<td>3 1/2</td>
</tr>
</tbody>
</table>
# Lund and Browder chart

<table>
<thead>
<tr>
<th>Age in years</th>
<th>0</th>
<th>1</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>Adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-head (back or front)</td>
<td>9½</td>
<td>8½</td>
<td>6½</td>
<td>5½</td>
<td>4½</td>
<td>3½</td>
</tr>
<tr>
<td>B-1 thigh (back or front)</td>
<td>2³⁄₄</td>
<td>3¼</td>
<td>4</td>
<td>4¼</td>
<td>4½</td>
<td>4³⁄₄</td>
</tr>
<tr>
<td>C-1 leg (back or front)</td>
<td>2½</td>
<td>2½</td>
<td>2³⁄₄</td>
<td>3</td>
<td>3¼</td>
<td>3½</td>
</tr>
</tbody>
</table>
Complications

Early

- Hypovolemia
- Fluid overload
- Renal dysfunction
- Hemoglobinuria
- Stress gastroduodenal ulcers
- Pulmonary dysfunction
- Local / systemic sepsis
Complications

Late

- Scarring — hypertrophic, keloid
- Contractures — limbs, neck

- Disfigurement
- Functional disability
- Posttraumatic stress
Cause of death....

- **Immediate to within few hours**
  - Primary shock - Neurogenic shock - due to pain
  - Asphyxia – inhalation of smoke, suffocation

- **Within first 48 hours**
  - Secondary shock – loss of fluid from burnt region

- **3-4 days**
  - Toxaemia – absorption of various metabolite from burnt region

- **4-5 days and later**
  - Sepsis, Gastric ulceration, Oedema of glottis, acute renal failure, Gangrene, Pulmonary embolism, ARDS, tetanus

- **Years after....**
  - Malignant transformation of burn scar (Marjolin’s ulcer)
## Age of burns

<table>
<thead>
<tr>
<th>Condition</th>
<th>Time Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erythema / Redness</td>
<td>immediately</td>
</tr>
<tr>
<td>Vesication</td>
<td>2 - 3 hours</td>
</tr>
<tr>
<td>Exudation dry up</td>
<td>12-24 hours</td>
</tr>
<tr>
<td>Dry crust formation</td>
<td>48 – 72 hours</td>
</tr>
<tr>
<td>Pus</td>
<td>2 - 3 days</td>
</tr>
<tr>
<td>Superficial slough separates</td>
<td>1 week</td>
</tr>
<tr>
<td>Deep slough separates</td>
<td>2 weeks</td>
</tr>
<tr>
<td>Granulation tissue - Scar form</td>
<td>weeks - months</td>
</tr>
</tbody>
</table>
Autopsy findings.....

- Remnants of clothing
- Smell of inflammable agent
- **External finding**
  - Reddening, Blister formation
  - Blackening, Charring and roasting
  - Singeing and burning of hair
  - Blood tinged froth
  - ‘HEAT RUPTURES’
  - ‘Pugilistic attitude’
  - Heat fractures
HEAT RUPTURES

- Area of severe burning
- Over fleshy area like calves and thighs
- Splits due to contraction of the heated and coagulated tissue
- Resemble like lacerated wound except that
  - Area of distribution
  - No infiltration of blood in surrounding tissue
  - Absence of blood clot
  - Presence of intact blood vessels and nerve stretching across the floor of the ruptures
Pugilistic attitude

- Boxing, fencing, or defense attitude
- Body exposed to great heat
- Legs flexed at hips and knees, arms flexed at elbows and wrists, fingers hooked like claws
- Stiffening due to coagulation of proteins of muscles
- Flexor muscles are bulkier than extensors
- Both in person alive or dead at time of burning
Heat fractures

- Skull fractures – common where skull is severely burnt
  - Two types:
    - Intracranial increase of steam pressure – separation of un-united sutures, fracture with gapping margins
    - Fracture due to rapid drying of the bone with contraction – involves only outer table of the bone. Several line radiating from common center
  - Curved fractures in bones of extremities
Internal findings

- Internal organs congested
- Presence of “HEAT HEMATOMA”
  - Resemble Extradural hemorrhage
  - Actually a artefact
  - Head is exposed to intense heat
  - Clot is Chocolate brown in colour
  - Clot is soft, friable and honey-comb appearance
- Tongue, larynx, trachea and bronchi inflamed and contains soot mixed with mucus
- Presence of CO in blood – bright pink appearance of blood
Antemortem Burns

- Presence of soot in trachea
- Thermal injury in Respiratory tract
- Line of redness (Vital reaction)
- Vesication
- Elevated CO in blood
- Presence of other toxic gases in blood
- Histopathological examination