

## Lecture Notes

### Wounds II



Types of Trauma, Physical & Biological Factors

#### Classification of Injuries

- Blunt Force Injuries ([Bruises](#), [Abrasions](#), [Lacerations](#), [Bites](#))
- Sharp Force Injuries ([Incisions](#), [Chop wounds](#), [Stabs](#))
- [Gunshot wounds](#) (separate lecture notes)
- [Burns & Scalds](#),
- [Electrical injuries](#)

Internal injuries, Effects of injury

Interpretation of Wound Pattern ([Self-inflicted](#), [Assault](#), [Accident](#), [RTA](#))

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## ***INJURIES OF MEDICO-LEGAL IMPORTANCE***

**WOUND:** (legal definition):' breach of the full thickness of the skin (or lining of lip). This excludes abrasions, bruises, internal injuries and fractures!

**WOUND:** (medical definition)' disruption of the continuity of the tissues produced by external mechanical force'

**INJURY:** from the latin *injuria* (in- not, jus- the law). The term is often used synonymously with wound but can have a wider use, including damage to tissues by heat, cold, chemicals, electricity, radiation, in addition to mechanical force

**LESION:** from the latin *laesio* (a hurt). Originally meant injury, now more widely applied to include " any area of injury, disease or local degeneration in a tissue causing a change in its function or structure"

**TRAUMA** - bodily harm with or without structural alterations resulting from interaction with physicochemical agents, imparting energy to tissues.

May cause morphologically apparent damage (wound) or produce physiological imbalance (eg reflex cardiac arrest by neural stimulation) and secondary effects (eg thrombosis, infection, obstruction of tubular organs)

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## ***TYPES OF TRAUMA***

Energy may applied to tissues in various forms :

### 1) **Mechanical Force**

**Blunt force trauma** (BFT)

- a moving object (KE) striking the body as in a blow
- the moving body (KE) striking a fixed object or surface as in a fall

BFT causes bruises, abrasions and lacerations

**Sharp force:** knife tip or edge, broken glass, jagged metal

- applied force is concentrated over a small area, requires little force to cut tissues

**Firearm:** high velocity, small mass projectile

2) **Thermal energy:** heat or cold

3) **Electrical energy:** flow of current may cause localised burn if resistance is high

4) **Atmospheric Pressure:** high or low, in air or water

5) **Radiation:** particle or radiation

6) **Chemical reaction** with tissue releasing energy

**Mechanical Force** may cause

Impact, Angulation, Compression, Traction, Torsion, Shearing, Acceleration/deceleration (RTA)

Different tissues have varying properties of

Elasticity (tendency of stressed material to regain its unstressed condition)

Plasticity (tendency to remain in stressed condition)

Viscosity (resistance to change in shape when stressed)

Different tissues therefore have different **elastic limits** (tolerance limits or break points) and are vulnerable to different stresses. **Skin** has greater elastic limit than underlying fat and blood vessels making subcutaneous bruising more common than skin laceration

e.g. torsion often causes spiral fracture of tibia, soft tissues undamaged

compression often causes rupture of gas-filled lung or intestine, but muscle and skin undamaged

Injury occurs when energy applied exceeds the elastic limits (or tolerance) of the tissues.

Whether or not injury occurs following the application of energy, in whatever form, depends on **Physical and Biological factors**.

## PHYSICAL FACTORS

1) **Degree of Force** or K.E. applied:

$$\text{Force} = \text{Mass} \times \text{Acceleration}$$

$$\text{Kinetic Energy} = 1/2 \text{ Mass} \times \text{Velocity}^2$$

Energy depends on **mass** of weapon or projectile, but on the **square** of its **velocity**

$$\text{Crash energy} = (\text{mph})^2 \times 0.034 \div \text{Stopping distance in feet}$$

2) **Area** over which force is applied:

-same force spread over larger area is less likely to injure at site of impact

edge or tip of knife allows a great concentration of force applied

edge of a plank is more damaging than its flat face

heel of stiletto is more damaging than its sole  
Soft object deforms and flattens

3) **Duration** over which force is applied:

longer duration allows tissues at site of impact to deform and dissipate the applied energy

eg fall onto soft surface (increases duration and area of impact)

seat belt stretching slows down the rate of transfer of kinetic energy to the body and spreads the area of impact over the trunk (c.f. forehead on dash)

4) **Direction** of application:

Transfer of kinetic energy from weapon or projectile is incomplete with a glancing blow or exiting bullet (some wounding potential is wasted) and complete when the weapon or bullet come to rest on/in the body

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## **BIOLOGICAL FACTORS**

1) **Mobility of the body part**

Fixed parts absorbs all applied energy.

Mobile parts are able to transform KE into movement

2) **Anticipation and coordination**

e.g.-boxer rolling with a punch spreads out the duration of impact, catching a cricket ball, rolling with a fall

3) **Biomechanical properties of tissue**

Different tissues have different strengths and weaknesses

-skin is elastic and more resistant than underlying tissues (Bruise > Laceration)

-blood vessels more resistant to compression than stretching

-bone more resistant to bending than to torsion

-hollow or fluid-filled organs sensitive to compression

-brain (semi-fluid) more resistant to direct impact than rotational impact (--> shearing of nerve fibres)

-bone and joint may transmit force to a weak point

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## ***CLASSIFICATION OF INJURIES***

(1) **Bruise**

(from Old English *brysan*-to crush,

Old French *bruser*-to break

Syn. Contusion, Ecchymosis

Defn. "escape of blood from ruptured small vessels (vein, capillaries, arterioles) into the surrounding tissues" The resulting discolouration is seen through the overlying intact skin. Due to blunt force trauma.

Site, shape, size, severity of bruising are very variable

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(2) **Abrasion**

From Latin *ab-* from and *radere-* to scrape

Syn. Scratch, Graze

Defn. " a portion of the body surface from which the skin or mucous membrane has been crushed or removed by rubbing"

A superficial injury, not involving the full thickness of the skin, i.e. confined to

epidermis/dermis.

Due to

- (1) Direct impact: **imprint** (may reflect pattern of causative surface) or
- (2) Tangential impact: **graze or scratch** (may reflect direction of impact)

**Always occurs at the site of impact**

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### (3) Laceration

From Latin *lacerare*- to tear. Botanical term- irregular edges

Defn. Full thickness tearing of skin or tissue due to stretching and crushing by blunt force

Characteristics: Ragged edge, Associated bruising/abrasion, Tissue bridges

Provides little specific information about the causal object

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### (4) Incision

From Latin *incidere*- to cut into. Surgical term incision with scalpel

Defn. Clean division of the full thickness of skin (or other tissue) by a sharp-edged instrument.

Characteristics: Clean cut edges, No associated bruising/abrasion, No tissue bridges.

Incised wound is LONGER THAN IT IS DEEP.

Provides little specific information about the causal object

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### (5) Penetrating or Puncture Wounds

Defn. Puncture is "a small hole made with a sharp point"

ITS DEPTH EXCEEDS ITS LENGTH on the body surface.

Due to a sharp/flat instrument, e.g. knife (**STAB**), a sharp/thin, e.g. needle (**NEEDLE PUNCTURE**) or a blunt/long/rigid, e.g. wooden stake (**PUNCTURE**)

Shape and size of wound often indicate dimensions of weapon.

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### (6) Thermal injuries

Application of dry or moist heat :**burns & scalds**

Cold injury

(7) **Electrical Burns** Heat produced by electrical flow.

(8) **Firearm Injuries** Small mass, high velocity projectile fired from gun.

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## ***BRUISES***

(Syn: contusions, ecchymoses)

From Old English *brysan*-to crush and Old French *bruser*-to break

Definition: leakage of blood from ruptured small vessels (veins or arterioles) into the surrounding tissues. **Haemorrhage** or bleeding is the escape of blood from any part of the vascular system. Haemorrhage can also be external, from a skin wound, or internal into a body cavity. Bruising is haemorrhage into the surrounding tissues. Bruising may be seen in skin, muscle or any internal organ.

**Petechiae**- pin head size bruise < 2mm

### Due to **BLUNT FORCE TRAUMA**

Moving object strikes the stationary body (**blow** with fist or weapon)

Moving body strikes a stationary object (**fall**)

pinching or squeezing

Often associated with skin abrasion or laceration (the more elastic overlying skin may be undamaged)

Bruising less often associated with incised or stab wounds which allow outward escape of blood from cut vessels

### **EXTERNAL BRUISING**

Superficial bruise rapidly appears at the site of impact. Bleeding in the subcutaneous tissue seen as discolouration through the semi-translucent skin

### **INTERNAL BRUISING**

Not visible at surface

Deeper bruise in muscle or internal organ will not be visible through overlying fat and skin. e.g. neck in strangulation, fatal brain injuries, blows to chest & abdomen

**The site of bruising does not necessarily reflect site of trauma.**

Bleeding into tissues may continue for some time after impact under circulatory pressure. Extravasated blood tracks along natural/traumatic planes of least resistance, influenced by gravity and body movement.

e.g. blow on temple --> bruise on cheek

fractured jaw --> bruising on neck

fractured hip --> bruise on thigh

### **Delayed appearance on body surface**

Deep bruising may take **upto 24 hours to appear** at surface (come out). Re-examination of a body or live victim after this time may reveal bruises not initially apparent. Ultraviolet light may disclose an otherwise unidentifiable bruise.

Breakdown of RBCs with time (haemolysis) releases breakdown pigments which may spread outwards and stain the tissues over a wider area than the original intact red blood cells of the fresh bruise. Pigments may spread closer to the overlying translucent skin thus becoming visible on the surface a few days after injury.

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### **DEGREE OF FORCE**

Skin has greater elastic limit than underlying fat and blood vessels making subcutaneous bruising more common than skin laceration. Degree of force cannot be accurately deduced from the size of a bruise.

Although heavy impact will generally cause a large bruise, severity of bruising depends on:

#### (1) **Anatomical site:**

over bony prominence (shin, cheeks), lax, vascular tissue (eyelid, orbit) fatty tissue (buttocks) will bruise easily.

Escaped blood has room to accumulate in lax tissues.

Resilient muscle of anterior abdominal wall rarely bruises (although there may be severe underlying visceral injury). Dense, tightly bound tissue, e.g. palms, soles, rarely bruises. Dense fibrous tissue physically restricts accumulation of blood.

(2) **Age**

Infants have loose, delicate, fatty tissues which bruise easily.

Elderly: degeneration of vessels and connective tissue allows easy bruising

(3) **Obesity & Sex**

Obese individuals bruise more easily than lean due to a greater proportion of subcutaneous fat

Females generally bruise more easily due having a greater proportion of subcutaneous fat than males

(4) **Disease of clotting**

"spontaneous" bruising (haemophilia, leukaemia and platelet disorders), some infections (meningitis), liver disease ( including alcoholism), vitamin C deficiency (scurvey), poor nutrition, medications

(5) **Skin colour** black skin may mask bruising. UV light needed.

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## **AGE AND COLOUR CHANGE IN BRUISES**

-immediately **DARK RED** (the colour of capillary blood)

-soon turns **DUSKY PURPLE**

-subsequent colour changes very variable in timing and result from HAEMOLYSIS by enzymes and cellular products.

Colour changes begin at the periphery and progress towards centre if large. Smaller bruises may change colour uniformly. Pigments, including bilirubin and haemosiderin are released from haemoglobin within degenerating red blood cells

Subsequent colour changes:

1. **BROWN**
2. **GREEN**           4-5 days or more
3. **YELLOW**       7-10 days or more
4. **STRAW**
5. **DISAPPEARS** 14-15 days (range 1-4 weeks)

A small bruise in a healthy adult may disappear in 1 week. A love bite (Hickey) may vanish in 2 or 3 days.

N.B. **The time course is very variable** time course depends on adequacy of lymphatic and venous drainage, size and depth of bruise, anatomical site, age of person (v. slow in elderly) and general health

Accurate dating of an individual bruise is difficult. **Distinguishing FRESH from OLD** is easier and often important, e.g. repeated assault, child abuse

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## **POST MORTEM LIVIDITY** (hypostasis, livor mortis)

The settling of blood into the lowermost blood vessels under gravity after the circulation ceases. Results in a pinkish discolouration of the skin in the dependent parts of the body.

Blood vessels compressed by pressure of contact with clothing or supporting surface will not fill and the area remains pale (contact or pressure pallor). Lividity is sometimes confused with bruising. Distribution and pallor help to discriminate. Incision of the skin shows oozing of blood from cut, engorged vessels which can be rinsed away in lividity. Incision of a bruise reveals escape of blood into the tissues which cannot be rinsed away.

Escape of blood cells and haemolytic pigments from vessels into the surrounding tissues due to **putrefactive breakdown** may be difficult to distinguish from bruising.

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**POST-MORTEM BRUISING** can occur but needs great force to produce small bruise. After death blood is under physical pressure only. There is only a passive ooze from blood vessels ruptured after death rather than the active extravasation under pressure which occurs in life. Most likely to occur within areas of post mortem lividity where blood is under greater physical pressure and over bony prominences where tissues may be crushed against the underlying bone, e.g. back of the head.

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**SHAPE AND SIZE** of bruises are very variable & poor indicator of causative object. Expansion and movement blur the outline. Some bruises inflicted with a small hard object, immediately prior to death may retain the pattern of the causative object. Rapid death will limit the extension and blurring of the outline which usually occurs under circulatory blood pressure. e.g. bumper, grille or headlight on pedestrian, neck ligature, blow over clothing or jewellery  
An associated imprint abrasion is more useful.

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## CLASSICAL PATTERNS OF BRUISING

**Patterned Intradermal bruise** due to impact with a hard, patterned object with ridges/grooves. Skin over ridges is compressed and vessels remain intact. Skin forced into grooves and dermal vessels ruptured. The resulting accumulation of a small amount of blood, near the epidermis may demonstrate the obvious pattern of the causal surface (tyre, shoe tread, car bumper, clothing, gun muzzle)

It is often useful to trace the outline onto an acetate sheet for later comparison.

**Finger pad bruises** are round or oval, slightly larger than the finger tips due to outward spread of blood. Due to gripping by fingertips in forceful restraint  
Found on -limbs and face (child abuse), thighs (rape), neck (throttling (manual strangulation)), arms (forceful restraint or post mortem movement of the body)

**Tramline bruising** due to a rod shaped weapon or stick. Compression of vessels centrally, not usually damaged unless crushed onto bone. Traction causes rupture of vessels along edges of rod. A solid stick bruise is limited to the convexity of the body surface (remember that a soft body part such as a buttock will mould and flatten. A flexible strap or flex will wrap around the convexity producing a longer and often curved tramline bruise.

**Doughnut bruise** due to a spherical object (cricket ball)

**Love bite (hickey)** Not a bite. No teeth marks. Suction bruise caused by firm application of the lips against the skin, forming an air-tight seal, oral suction causing a shower of petechial bruises

from rupture of numerous small vessels. Normally found on teenagers after the weekend! Also seen on neck, breasts in sexual assault. Must be human in origin. A similar appearance is seen between the dental arches of a true bite.

**Counter pressure bruises** of bony prominences of shoulder blades, sacrum and back due to forceful restraint against wall/ground. More common in muscles than skin.

**Black eye** (peri-orbital haematoma)  
fist blow to orbit  
fractured skull (R.T.A., gunshot)  
tracking from forehead bruise.

**Punching** is directed at the upper body, especially the face  
Causes bruising, abrasion, laceration over bony prominences and teeth, fractured nose & face.  
Bruising or abrasion of knuckles due to throwing punches

### **Kicking (or shod foot assault)**

Stamping, jumping may reproduce the pattern of the sole  
Glancing kick may cause a scuffed abrasion  
Direct blow (swinging kick) may result in bruising, laceration or a curved imprint abrasion

Typical target sites: face, neck, loin, groin, back, chest. Associated internal injury is often severe

### **Bruising of Various ages:**

suggests repeated assaults (child abuse, wife/husband beating, elderly (beating or poor balance), alcoholics)

### **Medical intervention**

-sternal and cardiac bruising  
-bruising around needle puncture marks  
-pinching skin to test conscious level (butterfly bruise)

N.B. Bruising usually due to Accident or assault; it is rarely self-inflicted (too painful and unimpressive!)

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## ***ABRASIONS***

(Syn: grazes, scratches)  
From Latin ab- from and radere- to scrape

Definition: "a portion of the body surface from which the skin or mucous membrane has been removed by rubbing" (from the Latin ab- from, and radere- to scrape).

A superficial injury of the skin not involving the full thickness of the skin (confined to epidermis and papillary dermis, or body lining epithelium). Usually due to BFT, exception is a scratch

### **2 Types:**

1) Loss or scraping of epidermis/dermis by **TANGENTIAL FRICTION** on rough surface (graze) or sharp point.(scratch)

2) Superficial crushing of epidermis/dermis caused by **DIRECT IMPACT**. More often seen in fatalities



Many abrasions have both a vertical and tangential component.

Abrasions are **clinically trivial**, although they are painful, bleeding/exudation is slight and leads to crust/scab formation. Heals without scarring (by re-epithelialisation). Abrasions are often associated with bruising and laceration

**FORENSICALLY VERY IMPORTANT.** Often the most informative of all injuries:

**Always reflect site of impact**

**Often indicate causative object/surface**

**Often indicate direction of impact**

Assessment of age of abrasions is difficult. Post-mortem drying of abraded surface causes a golden yellow or reddish, leathery, **parchmented** appearance.

1. **DIRECT VERTICAL IMPACT causes Crushing of epidermis**

The causative object may stamp its shape or surface pattern on the skin -->

**IMPRINT ABRASION**

- e.g. Rope weave in hanging or ligature in strangulation  
Fabric weave of seat belt, clothes, whip  
Tyre tread in RTA  
Bite mark ( double crescent of spaced linear impressions)  
Fingernail impressions (crescentic) on neck in throttling, neck, wrists

thighs and vulva in rape

2. **TANGENTIAL IMPACT**

Due to a glancing (tangential) impact by a moving object against stationary body or the moving body against a rough stationary surface.--> **scraping of epidermis** due to friction against a rough or sharp surface.

Stratum corneum and superficial epidermal cells removed, causing exudation of fluid. Deeper loss of epidermis may expose capillary loops in papillary dermis and cause bleeding

Direction of impact can often be assessed: starting edge has bevelled descent; a series of parallel furrows indicate direction of sliding motion; finishing edge has tags of heaped epidermis

- e.g. R.T.A. -body thrown across road surface (gravel rash)  
Falls  
Assault with a rough surfaced instrument.  
Finger nail scratches (same sites as imprint nail marks but drawn across surface.

Depth and breadth often useful for comparison with assailant)  
Dragging of dead/injured away from scene of crime.

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## ***BITE MARKS***

Teeth marks may be abrasions, bruises or lacerations, or a combination. Clarity depends on contour of part bitten and the force applied.

Animal bite is deeply arched or 'U-shaped'. Human bite is near circular or shallow oval

Size -indicates whether inflicted by an adult or child

Teeth may close down on flat surface but more often a block of tissue is drawn into the mouth. Results in suction bruise (hickey) between the dental impressions. Shape of resulting bite mark is affected by flattening on release. Human bite may present as a series of separate bruises with

central linear abrasions or a continuous, curved line of bruising. The mark may represent only part of the dental arcade

When fresh, may provide useful evidence of assailant's identity:

Size and shape of dental arcade influenced by distinguishing features  
e.g. Missing teeth, Displaced teeth

Allows comparison with suspect. Bruising due to individual teeth spreads out and blurs, causing progressive loss of definition. Early expert dental opinion and photographs required.

Seen on breasts, neck, thighs, abdomen and vulva in sexual assault. Any site in child abuse.  
Fights, including sport (rugby, wrestling & football!)  
Self-inflicted (fabricated assault, psychiatric). Accessible!

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## ***LACERATION***

From Latin *lacerare*- to tear. Botanical term- irregular edges

Definition: Full thickness tearing of the skin (or other tissue) due to stretching, pinning and crushing of tissues by blunt force trauma.

BLUNT FORCE TRAUMA by moving object or fall.

Pinning, crushing and stretching forces result in splitting and tearing of tissues.

Same type of trauma which causes bruising and abrasion but full thickness injury

Typically over BONY PROMINENCES where tissue is **pinned and crushed** against underlying bone, e.g. scalp, eyebrow, cheek, shin

A single blow may cause more than one laceration

Soft tissue areas of limbs may be lacerated by a **blunt projecting object which pulls obliquely** against the tension of the skin causing stretching and tearing.

**Rolling/grinding** movement of vehicle wheel strips and tears

**Lacerations are characterised by:**

- 1). Ragged edges (torn apart), bulging fat, crushed hair bulbs
- 2). Associated Bruising and Abrasion of skin edges and adjacent tissue (BFT)
- 3). Tissue Bridges in depth of wound (intact nerves, vessels, tendons)

A tangential component may give one clean-cut edge, other ragged, undercut or flap-like.

### **CLINICAL IMPORTANCE**

Often little external blood loss (except scalp) due to crushing and retraction of vessels.

Associated internal injury/bleeding. Wound infection frequent (F.B.).Heals by scarring

### **FORENSIC IMPORTANCE**

1. Shape and size not usually related to causal object
2. Trace evidence in wound (F.B.)
3. Rarely self-inflicted

### **EXAMPLES**

Crescentic/circular ... round-headed hammer

Y-shaped ... metal rod

Inside lips (trauma against teeth) ... blow to mouth  
Flaying laceration ... rolling/stretching of skin over limb in R.T.A.  
Perineum ... rape  
Stellate ... heavy vertical blow.

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## ***INCISED WOUNDS***

Syn: cuts, slashes

From Latin incidere- to cut into. Surgical term incision with scalpel

Definition: Clean division of the full thickness of skin (or other tissue) under the pressure of a sharp-edged instrument.

An incised wound is LONGER THAN IT IS DEEP due to **swipe** action.

Instrument is **sharp-edged, such as:** knife (linear, clean), jagged metal (irregular, jagged), broken glass

### **CHARACTERISTICS OF AN INCISION~**

- clean cut, everted edges
- no tissue bridges or abrasion of margins
- linear or elliptical shape, often gapes
- often deeper at starting end
- jagged if inflicted through loose, folded skin.

**Chop wound** is a variant of an incision. Has clean-cut edges but an abraded margin due to inversion and friction against the sides of the wide blade on insertion.

### **FORENSIC IMPORTANCE**

Reflect sharp edge, not weapon type

No trace evidence

Profuse external haemorrhage and air embolism

Danger to life depends on site and depth

Incised wounds may be **Self-inflicted, assault or accident.**

### **SELF INFLICTED**

At sites of election (wrists, neck, cubital fossae, chest, abdomen, groin)

#### **Suicidal cut Throat:**

tentative incisions (left side of neck if right handed), one or more deep, sweeping cuts, down from the left, across the mid-line, up towards the right ear. Sshallow --> deep centrally --> shallow. Cut slopes upwards and backwards.

Incision is usually through level of thyrohyoid ligament and may be down to spine! Repetitive nicks at the base of the wound (sawing). Bleeding is venous, loss of consciousness is slow. Air embolism may occur.

### **OTHER SELF-INFLICTED INCISIONS**

Fabricated assault - superficial wounds to head, left arm, chest abdomen, thighs.

Parasuicidal mutilation - face, arms, trunk ... low self-esteem

### **ASSAULT INCISIONS**

Compared to suicidal cuts, homicidal cuts:

- lack the unhurried election of site. May be aimed, but many miss.
- lie both higher and lower across neck
- no tentative cuts, all are forceful and deepen rapidly

- no repetition in same track
- slope backwards and downwards
- associated with 'defence injuries' to hands and arms

### **ACCIDENTAL INCISIONS**

- random pattern
- usually single
- often deep and forceful

## ***PENETRATING WOUNDS***

(Syn: Stab & Puncture wounds)

Puncture is "a small hole made with a sharp point"

Definition: Penetrating injuries caused by separation of the skin and soft tissues under the pressure of a sharp or blunt pointed instrument, the greatest dimension being its depth.

ITS DEPTH EXCEEDS ITS LENGTH on the body surface.

Often appear trivial externally (short incision or laceration) **BUT** often causes internal trauma and haemorrhage.

Caused by thrusting of (or falling onto) 3 types of instrument

- (1) Sharp and flat, e.g. knife **STAB**
- (2) Sharp and thin, e.g. needle **NEEDLE PUNCTURE**
- (3) Blunt, long and rigid, e.g. wooden stake, spike, screwdriver, tooth **PUNCTURE WOUND**

PENETRATING - passes into but not through organ

PERFORATING OR TRANSFIXING - from Latin *perforare*, *per-through* & *forare*- to bore  
passes through and through an organ

## ***STAB WOUNDS***

Descriptors of penetrating wounds

- a) Damage to clothing (slashes, stabs through folds, blood flow & drip patterns, trace evidence)
- b) Site in relation to anatomical landmarks, midline, heel.
- c) Shape
- d) Alignment (horizontal, vertical, oblique)
- e) Size : length & width with edges opposed
- f) Direction :in 3 planes
- g) Depth
- h) Damage to tissues along track
- i) Effects : external & internal haemorrhage, pneumothorax, air embolism

Adequate description may provide vital information about :

- 1) Type of weapon (c): usually a knife
- 2) Dimensions of the weapon (e)
- 3) Taper of blade (e)
- 4) Movement of knife in wound (c)
- 5) Direction of thrust (f)

- 6) Depth of thrust (g)
- 7) Amount of force used
- 8) Likely effect on victim (h, i)

## WOUND LENGTH

A straight in and out stab wound is slightly shorter than the width of the blade due to stretching of the skin over the point of the knife on insertion and elastic recoil on withdrawal. Wound length and width must be assessed with the edges taped together because the wound is often shortened and widened into an ellipse by skin elasticity (Langer's lines of tension) and underlying muscle tone.

### Wound length < blade width

- (1) stretching of skin over point on insertion and subsequent recoil on withdrawal.
- (2) tapered blade not fully inserted

### Wound length > blade width

when blade does not pass straight in and out - entry and withdrawal at angle.  
"Rocking" of knife on withdrawal. Cutting edge extends wound length

The best indicator of blade **width** is the shortest (least rocking), deepest wound (weapon fully inserted)

**SHAPE OF WOUND** May indicate:

#### (1) **Cross-sectional shape of knife blade**

e.g. - Double-edged blade --> Slit with two sharp ends

N.B. single edged knife may give similar wound due to clean splitting over blunt end

- Thin, single edge blade --> Triangular slit, one sharp end

- Thick, single-edged blade --> Slit with one sharp and one 'fishtail' end due to stretching & laceration over blunt edge

Stab wounds are typically elliptical with clean cut edges and no bruising or abrasion of margins (incision)

#### (2) **Direction of insertion** overhang of upper edge, bevel of lower edge

N.B. The direction of the wound track through the tissues is assessed at post mortem, with the body lying flat on its back. The position of the internal organs is different in life, when standing, sitting and breathing.

#### (3) **Movement of instrument on withdrawal**

Small change in angle --> notch

Twisting --> crescentic wound

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## WOUND TRACK DEPTH

< length of instrument if not fully inserted

> length of instrument if fully inserted and body surface compressed e.g. abdomen, chest.

A small penknife can perforate heart or abdominal aorta.

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## DEGREE OF FORCE

Wound depth is a poor indicator of force applied

Pressure required to penetrate is often slight with sharp tipped instrument

Depends on sharpness of point, not of cutting edge. Sharp tip requires little force to penetrate, blunt tip requires greater force.

Speed of weapon's approach ( $F = \frac{1}{2} m v^2$ ): quick thrust penetrates skin more easily than slow, sustained pressure

Bony damage is useful indicator of depth and implies significant force

Most resistance offered by CLOTHES AND SKIN

The compressed skin 'gives' suddenly, releasing the energy stored in the compressed skin and tissue (elastic reservoir). Once the skin has been penetrated, the blade slips easily through the underlying muscle, internal organs and uncalcified cartilage, without the need for further application of force.

### **Analogy is stabbing a melon**

Penetration of bone requires considerable force and may break the tip off the weapon.

A quick stab requires less force to penetrate than a slow push.

Forceful insertion may cause imprint abrasion or bruising of skin by the hilt of the knife.

Rare, most often on chest

Remember to consider counter-pressure by victim: falling or running onto instrument. The knife does not need to be supported rigidly if tip is sharp. Considerable force and determination required to remove knife from clothed body.

### **EFFECTS OF STABBING**

Victim may not initially be aware of injury.

There may be little or no external blood loss.

Internal blood loss may be profuse and rapidly fatal or slow enough to allow time for medical treatment.

Main effect is bleeding. The time taken to incapacitate the victim and what actions are still possible is very difficult to estimate.

A stab to the **heart** may bleed profusely out into the confined space of the pericardium. If pericardial defect is small or does not communicate with the pleural cavity cardiac tamponade may result (200-450ml). **Left ventricular** wound may partially reseat, resulting in slow blood loss or spontaneous healing. Thin-walled right ventricle less likely. Great vessels do not re-seal.

Rate of bleeding from stab wound to the **lung** depends on the size of vessels cut. Large pulmonary veins & arteries branch outwards from the hilum. Peripheral stab bleeds less and may seal if lung collapses. Pneumothorax may itself be fatal. Cut through bronchus may bleed and obstruct airways.

**Abdominal** stab may penetrate major vessels, liver or spleen with rapid haemorrhage into the abdominal cavity.

Stabbing to the **head** and face may allow penetration of bone in the region of the eye, nose and temple where bone is relatively thin.

Pulmonary **air embolism** originating in a partially severed jugular vein may be rapidly fatal before much blood is lost. Severing a carotid artery or jugular vein results in rapid exanguination.

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## ***PUNCTURE WOUNDS DUE TO BLUNT INSTRUMENTS***

Blunt instrument typically --> Irregular, split, laceration-like wound. Greater force needed to penetrate skin.

Inversion of skin on entry causes abraded margin.

Crushing and stretching of the tissues causes bruising of the margins.

Shape may indicate cross section of instrument.

e.g. Hayfork --> Elliptical  
Ice pick --> Round  
Wooden stake --> Cruciate  
Poker --> Stellate laceration  
File --> Triangular laceration  
Scissors --> Depends on degree of closure. 'Z'.  
Animal tooth

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## ***ASSOCIATED INTERNAL INJURIES***

Surface wounds may be informative but are often simply the trivial markers of lethal underlying injury.

**Head injury** (separate lecture notes)

by fall, blow or RTA

Head is heavy, mobile and unstable. Scalp bruising and laceration common over bone.

Skull deformed by impact. If excessive skull may fracture at the site of impact:

linear, radiating, depressed, hinge, ring, contre-coup.

Injury to blood vessels and brain may occur without overlying fracture.

**Analogy:** blancmange (brain), wrapped in cling film (arachnoid), in paper bag (dura), inside a cardboard box (skull), wrapped in brown paper (scalp).

Any layer may be damaged by impact (blow) or dropping (fall)

**Intracranial haemorrhage** often follows head injury:

**Extradural-**

fracture tears artery~

- easily overlooked (concussion, lucid, coma)
- immediate or delayed accumulation of blood
- causes pressure on brain
- amenable to surgical decompression

**Subdural** - common in elderly, children, alcoholics

- small bridging veins torn by trivial impact or rotation
- may remain asymptomatic, partially healed and an incidental finding at

autopsy

**Subarachnoid-** natural (aneurysm rupture) or traumatic,

- ass. with contusion, laceration of brain
- or blow to side of neck
- often rapidly fatal

**Brain injury**

-may occur without fracture or intracranial haemorrhage

-rotation & accel/decel. injury more damaging than direct impact against the fixed, immobile head

-blow accelerates the head causing contusion at the point of impact (**coup contusion**)

-fall decelerates the head causing more obvious contusion at the diametrically opposite point

(**contre-coup**) contusion where the brain glides over the irregular, jagged contours of the skull.

### **Analogy is box of jelly**

Coup= Kick (head is accelerated)

Contre-coup= Dropping the box (all contents decelerated)

Typically a backward fall striking the back of the head (occiput) on the ground causes scalp abrasion, bruising or laceration with localised coup contusion at the occipital pole and more marked contre-coup contusion over the frontal and temporal poles where skull surface is rough. May also occur in a fall onto one side but not after a forward fall.

Greater force may **lacerate** the brain

Deep **intracerebral haemorrhage** may occur

Widespread subtle microscopic nerve fibre (**Diffuse Axonal Injury**) injury is common due to shearing stress of rotational impact or deceleration **Analogy is shaking or kicking a TV set**  
Associated swelling (**cerebral oedema**) is often fatal by raising the pressure within the cranial cavity (raised ICP) squeezing and damaging vital structures.

### **Facial injury**

-accidents (RTA)

-assault by punch, kick, blunt weapon

-fragile facial bones susceptible to injury

-bleeding into nose, mouth and sinuses often profuse, may obstruct air passages.

### **Neck injury**

-vulnerable area, access to vital structures such as the trachea, large vessels (carotid arteries, jugular veins)

-sensitive major nervous connections and reflexes

-cervical spine and spinal cord

-incisions, stabs, blows and pressure very dangerous (air embolism)

### **Chest injury**

-heart, major blood vessels and lungs vulnerable to impact, compression and penetration

-blunt impact of RTA is common

multiple rib #'s prevent respiration

pneumothorax, lacerated lung, heart.

-lacerated aorta due to deceleration

-site of election for stab and gunshot wounds with profuse haemorrhage into pericardial sac or pleural cavities

### **Abdominal injury**

-Abdominal skin injury is rarely seen, particularly if impact is over a broad area

-Liver, spleen, kidneys, intestines are vulnerable to compression and laceration against the spine following the blunt impact of RTA or assault

-Site of election for stab wounds with penetration of vascular organs such as liver, spleen, kidney, mesentery or major vessels such as aorta, vena cava with severe blood loss into the peritoneal cavity

-Peritonitis may follow intestinal damage.

### **Limb injuries**

Common in many accidents (RTA), falls, assaults

Fracture (#)(= a disruption in the continuity of a bone)

Result of direct or indirect force,

may be complete or incomplete

closed (simple) or open (compound)



transverse, longitudinal, oblique, spiral  
comminuted (more than 2 fragments)  
compression # of spine, 5th metacarpal (boxer's #)  
depressed # of skull  
stress #  
pathological # in weakened, diseased bone (osteoporosis, malignancy)

**Fat embolism** clusters of fat cells escape from within the central marrow cavity of a fractured bone or subcutaneous fat and enter the circulation via veins. Become entrapped in the small vessels (mainly capillaries) of the lungs or may pass through the lungs to block the capillaries of the brain, kidneys, heart and elsewhere. Pyrexia, skin rash, coma, renal failure. May be fatal.

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## ***SURVIVAL TIME AND ACTING CAPABILITY AFTER WOUNDING***

Post-injury survival time is important in reconstructing events

**How long did the victim survive?**

**Was the victim still capable of fighting, resisting or fleeing?**

Some injuries are incompatible with any significant survival, however fit or young the victim. Destruction of the brainstem or arch of aorta cause almost instantaneous loss of consciousness and rapid death.

Multiplicity of wounds and involvement of the heart and brain are associated with a short post-injury survival period. The effects of injury to major nerves, muscles and joints, followed by bleeding and shock will ultimately incapacitate the victim. The time taken to do so, and what actions are still possible is very difficult to estimate. A surprising amount of activity is often reported following infliction of an obviously lethal injury. Many remarkable examples in the literature. Levy & Rao suggest that overall, 71% of stab wound victims and 49% of gunshot victims survive at least 5 minutes. The victim may not be aware of the injury initially. Pain is suppressed by the adrenaline response of "fight or flight" and vigorous activity may be maintained for a period of up to a few minutes when the will exists. Such activity will cease when physical factors such as blood loss lead to immobility, loss of consciousness or death. Main effects of injury are bleeding and shock. Will ultimately incapacitate the victim. The time taken to do so, and what actions are still possible is very difficult to estimate. Activity varies from staggering a few paces to running considerable distances or up flights of stairs. Estimation of survival period is almost impossible. Numerous variables exist. Fit young adult will survive longer and be capable of greater activity than an elderly, infirm individual. Extensive destruction of the frontal cerebral lobes of the brain may permit survival and activity before death occurs from associated brain damage and shock.

A stab wound through the **left ventricle** of the heart may almost completely seal itself by contraction of the cardiac muscle around the defect. Survival of such a wound is common. Death will only occur if continued leakage of blood into the pericardial sac interferes with the pumping action of the heart (cardiac tamponade).

A stab wound through the thin-walled **right ventricle**, atrium or coronary artery is unlikely to re-seal itself and will bleed out into the pericardium with fatal results.

Wounds involving the **great vessels** of the thorax (aorta, vena cava, pulmonary arteries and veins) bleed profusely and offer no chance of closure.

**Arteries** carry blood at higher pressure than veins of similar size and therefore bleed more rapidly when cut.

A partially transected vessel is less likely to seal off than one which is cleanly divided.

The victim may remain alive for several hours with **internal blood loss** in excess of 2 litres. Consciousness may be maintained despite internal blood loss of 1.5 litres. The rate of blood loss is an important factor.

An incised wound on the neck involving a **jugular vein** may prove rapidly fatal before much blood has been lost. The cut vein may draw in air which then forms a fatal air-lock (air embolism) in an artery supplying the brain.

Stab wounds are typically slit shaped, allowing the possibility of closure of the wound due to skin and soft tissue elasticity. For this reason external blood loss is less profuse than from the gaping defect of a gunshot wound at the same site.

Acting capability and survival time do not appear to be influenced by the degree of alcohol intoxication.

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## ***INTERPRETATION OF WOUNDS***

### **(1) Causative object or weapon**

Imprint abrasion from direct impact with patterned surface  
Trace material in sliding abrasion, laceration  
Stab may indicate shape, width, length of instrument

### **(2) Order of Infliction**

Tentative or scattered FIRST  
Fatal or grouped LATER  
Distant shots before close shots

### **(3) Manner of infliction**

By assessment of Circumstances, Scene of death, Pattern of injuries as a whole

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## ***SELF-INFLICTED:***

Gunshot wounds and ncised or stabbed wounds with sharp or pointed object. are preferred  
Blunt force injuries are rarely self-inflicted.

Accessible target sites (often unilateral with "handedness")

e.g. incisions to wrists, cubital fossae, neck, groins  
stabs to chest (precordium), abdomen (epigastrium)  
shots to mouth, temple, heart

Clothes drawn aside

Multiple, Shallow, Tentative "Hesitation wounds"

e.g. incisions to wrist and neck  
stabs to chest and abdomen

Closely grouped, Parallel, Same Direction

e.g. "sawed" incision in same track  
stabs at same angle  
partial withdrawal and reinsertion

One or two potentially fatal

Scars from previous attempts

More than one method tried

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## ***ASSAULT:***

Any type of wound (abrasion, bruise, laceration, incision, stab, gunshot) frequently in combination

Punching -directed at upper body , especially the face. Causes bruising, abrasion, laceration over bony prominences and teeth and fractures of nose of facial bones

Kicking-stamping, jumping --> pattern of sole

    glancing kick --> scuffed abrasion

    direct blow --> bruising, laceration. May also see a curved imprint abrasion

Sites: face, neck, loin, groin, back, chest.

Associated internal injury is often severe

**Sharp force is favoured** -stabs & incisions

- Any site - often inaccessible to victim, e.g. back!

- Usually multiple

- Wounds aimed at vital area but scattered and grouped

A single wound suggests the victim was sleeping, drunk, drugged or incapacitated. The single wound is usually targeted (stab to heart, shot to head)

- Lack the unhurried site of election - no time to chose

- Inflicted through clothes

- More uniform force

- Multiple directions e.g. of incisions or stabs

- Several may be potentially fatal

- Associated defence injuries

**Defence injuries**- a pattern of injuries sustained by taking protective action against **anticipated** trauma (accidental or assault). Indicates that victim was conscious, not completely suprised by attack and at least partly mobile.

Typically seen on hands and forearms.

    Bruises, abrasions, incisions, stabs, gunshots

    Absence does not exclude assault (surprised)

Secondary injuries due to falls onto nearby objects

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## ***ACCIDENTAL***

Any type of wound, any site, usually single

Clothing involved, defence and secondary injuries common.

### **The Road Traffic victim**

#### **1) Pedestrian**

Most vulnerable road user. Particularly children & elderly.

The dynamics of the crash depend on the relative heights above the ground of the impact site and the centre of gravity of the pedestrian.

Impact below centre of gravity throws victim onto bonnet (or roof at greater speed). Victim acquires velocity of vehicle only to be thrown onto the road surface by violent braking.

Impact at C of G shunts victim in direction of travel

Impact above C of G throws victim under vehicle

**Primary injuries** are due to direct impact of vehicle against victim.

-Car bumper injury to lower leg, if fixed by weight bearing (bruise, abrasion, laceration, fracture). The height of injury above heel of shoe is important.

-A high fronted van will hit the thigh.

-Flat fronted lorry or bus hits torso.

-Primary injuries may harbour trace evidence (paint, metal) of evidential value in 'hit and run' collisions.

**Secondary injuries** are due to impact against the bonnet, windscreen, road surface or other object/vehicle.

-Bonnet & windscreen frame may fracture skull or injure chest & abdomen.

-Thrown onto the road injures head, chest, abdomen ---> Typical sliding abrasions, lacerations.

**Running over** results in flaying lacerations to the limbs.

**Speed of impact** cannot be estimated from the severity of injuries. Can only state whether injuries were mild, moderate or severe. Skid marks offer the only objective evidence of vehicle speed.

<b>Speed of impact</b>	<b>% Fatalities</b>
19-24 mph	10%
24-30 mph	47%
31-36 mph	73%

50% of fatalities are hit at speeds less than 30 mph. 50 % of those seriously injured are hit at less than 21 mph

2) **Vehicle occupants** Occupants move towards the point of impact.

There are 5 main patterns of impact:

1-**Head on** into a stationary object like a tree, another vehicle (speeds and impact energy additive)

The driver and front passenger may strike

-dashboard, windscreen & pillars (skull & brain);

-steering wheel (chest-lacerated lung & heart);

parcel shelf (# knees & pelvis)

pedals trap the ankles

-rear passenger hits seatback or over into front

-deceleration causes whiplash (flex/extension) neck, DAI brain injury and ruptured

thoracic aorta

2-**Rear impact** -speeds subtractive

- seats and head restraints support torso and neck
- whiplash (extension/flexion) with no restraint
- risk of petrol fire

### 3-Side impact -direct

- risk of side intrusion
- Left: limb, spleen, L kidney, lung
- Right: limb, liver, R kidney, lung

### 4-Side swipe -glancing

- less risk of side intrusion

### 5-Roll over -less damaging (rolling spreads the time of impact) unless occupant is ejected

### **Seatbelts**

Extremely effective in reducing mortality and injury in low to medium speed impacts:

- diagonal strap restrains upper torso (prevents impact with steering wheel, upper dash)
- horizontal strap restrains lower torso and pelvis, (prevents impact with lower dash, parcel shelf)
- area of straps spreads deceleration force over a wider area than localised impact
- stretching of strap fabric increases the time over which the decel. forces are spread
- prevents ejection through windscreen or burst door

Seat belt injuries are common

- bruising across chest & abdomen
- neck injury and carotid artery rupture
- fractured sternum, ribs, clavicles
- lacerated mesentery, bowel
- lumbar spinal injury

Rarely more damaging than if a seatbelt is not worn.

### **Other safety features**

- airbags
- crumple zones absorb impact energy and increase the duration of impact
- laminated windscreens deform without shattering and prevent ejection
- side impact bars
- burstproof door locks to prevent ejection
- padded steering wheel and collapsable column
- breakable controls and mirrors

### 3) **Motor Cyclist**

High speeds, unstable, no protection, difficult to see.

Primary impact injury may be to leg.

Secondary head, neck, chest and abdominal injury

Helmet and leathers provide the only protection.

Energy must be dissipated by sliding or rolling along the road.

### **Contributory Factors** in crashes

Intoxication-alcohol, drugs, carbon monoxide.

Human factors- reckless, speeding, inattention, fatigue, inexperience, shoes.

Environmental- fog, rain, ice, snow, leaves, sun, obstruction to vision.

Mechanical failure-tyres, brakes, steering.

Natural disease-Ischaemic heart disease, stroke, epilepsy.

Usually warning symptoms give enough time to pull over.

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# ***BURNS AND SCALDS***

Extent of heat-induced injury depends on

1. the applied temperature
2. the time for which the heat is applied
3. the ability of the body surface to conduct away the excess heat

5 hours at 4°C or 3 seconds at 60°C will cause a burn

Heat may be applied by Conduction from solid, Convection from liquid or gas, Radiation  
-absorption of infra-red

**Burns** (dry heat) Classification of severity (Wilson)

**FIRST DEGREE** - erythema & blistering.

Split in epidermis or at epi/derm junction

painful due to exposure of nerves

no loss of dermis

capillary dilation, swelling and exudation

blister, surrounded by zone of hyperaemia. Blister resorbs or bursts.

re-epithelialises, no scarring.

**SECOND DEGREE** destruction of the full thickness of skin

not painful as nerves destroyed

epidermis coagulated or charred

central necrosis surrounded by zone of hyperaemia or FDB

central area sloughs, epidermis grows in from edges and from epidermis in surviving

dermal structures (sweat, hair follicle)

underlying zone of tissue is precarious, may necrose if hypoxia or infection

supervene.

scarring centrally. Contractures may occur

less painful than FDB

Skin normally prevents water loss, regulates body temperature and prevents infection. Burnt skin loses salt-rich fluid from the circulation, resulting in low blood pressure (shock) and renal failure. Correction of fluid deficit is main initial aim of treatment. Swelling of burnt skin may result in touniquet effect on venous return and eventual arterial obstruction and tissue ischaemia and necrosis. Skin of limb or chest may need to be incised to relieve pressure. Infection often occurs and prevents skin grafts from taking.

Rule of Nines indicates clinical prognosis: each arm is 9% of body area, leg 18%, anterior trunk 18%, back 18%, head 9%. Palm is 1%. Involvement of 30-50% of body surface usually unsurvivable (less in elderly, more in children)

**THIRD DEGREE**

destruction of underlying fat, muscle, bone. When application of heat is prolonged the tissues may be charred, carbonised or completely destroyed. Dead body may show wide variation in severity from reddening to complete destruction of a body part. Post mortem burning obscures ante-mortem burns. Blisters will have collapsed with shreds and sheets of white epidermis over an angry red base. More severe burn --> stiffened, yellow-brown leathery skin due to partial carbonisation. PM drying of exuding skin --> parchmented surface. Skin surface often blackened by soot deposition. Hair 'clubbed' by melting and re-solidifying, or completely burnt away. Skin may ignite with subcutaneous fat burning as a fuel, clothes as a wick. Underlying muscle becomes pale, brownish (part-cooked). Max. effect with prolonged exposure - slow cooked muscle underlying intact skin. Deep muscle dehydration and denaturation causes PM contracture; the flexor groups more powerful --> 'pugilistic attitude'. Intense, prolonged heat

may destroy all soft tissues. Even bone may be reduced to brittle, grey-white splinters.

Spurious wounds appear e.g. heat fracture, heat haematoma (extradural), skin splits

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**Scalds** (moist heat) Injury by hot liquid -water, steam, oil, other. Not accompanied by charring, carbonisation or hair singeing as seen in dry heat. Resemble first degree burn -red, desquamation, blistered. Intensely red base covered by wrinkled, macerated epidermis. Swelling and exudation of serum. Scald sharply demarcated by limits of contact with hot liquid.

**Immersion** (relatively long period of contact with liquid) -> uniform area of injury with a horizontal fluid level, though irregular if splashed

**Tipped or splashed** - Momentary contact, falling away under gravity with rapid cooling. Injury occurs in short period of time, necessitating very hot or boiling liquid. Liquid runs under gravity -->trickle pattern. Areas of initial contact most severely scalded. Infection may supervene. Death most often the result of shock, fluid and electrolyte disturbance.

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## ***ELECTRICAL MARKS***

Severity of tissue damage depends on voltage applied and its duration, resistance of tissues and the current which flows. Body must form part of an electrical circuit so that current flows from an entry point to an exit point if injury is to occur. The path taken from entry point to exit point depends on the relative resistance of possible exit points. Takes shortest route between entry and best exit point. Entry and exit on same hand may cause severe burn.

Shock may be fatal if current flows across a vital part of the body,  
e.g. hand to opposite foot, across heart causing ventricular fibrillation (VF).  
across chest --> respiratory muscle paralysis  
through head --> cardiac & resp. centre paralysis

240 V entering finger, through carpeted, upstairs wooden floor (poor earth, low current flow) gives painful spasm. 240 V entering finger, through wet, ground level, concrete floor (good earth, high current flow) potentially fatal.

**$V = I \times R$ , and  $I = V/R$**  (Ohm's Law)

Alternating current (AC) is more dangerous than Direct current (DC) as it is more liable to cause cardiac arrhythmia. DC used in defibrillator to revert to sinus rhythm.

AC of 40-140 Hertz or cycles per second is most dangerous. Domestic mains supply is 50 Hz.

### Current

Injury depends on quantity of electrical flow ( Amperes, or more accurately, Coulombs, the product of amps x seconds)

30 mA applied to hand --> painful muscle spasm

40 mA --> unconsciousness

50-80 mA for > few seconds --> often fatal.

### Voltage

Considerable voltage must be applied to dry skin to cause flow of 50 mA.

Voltages of 24 or 100 Volts may be lethal if applied for long time.

Very high voltage may be paradoxically safer as muscle contraction caused by shock may physically fling subject off the source. 240 V applied to hand may cause forearm muscle spasm,

gripping the source and prolonging contact.

### Resistance

The skin is the major barrier to electrical current, having very high resistance. Burns occur when current flows due to energy transfer to heat. Once inside dermis, current flows more easily through electrolyte-rich cytoplasm and blood vessels. Resistance of dry skin : 1000 000 Ohms, wet skin : 1200 Ohms. More current flow for given voltage.

### **The electrical skin mark**

The electrical mark is a type of localised thermal burn due to heat production when current flows through highly resistant skin. Seen at point of entry, usually hand, and exit or earthing point. There may be no skin mark, even in fatality. If the skin is damp or the area of contact is wide (less resistance per unit area) then the heating effect is proportionately less

### Firm contact with conductor

Passage of current heats up tissue fluids to produce steam which splits skin within epidermis or epidermo-dermal junction. When current ceases the blister collapses to produce a raised white or grey ring with a depressed centre. The mark may reproduce the shape of the conductor e.g. linear wire or shaped metal object.

Loose contact (narrow air gap) Current leaps the gap as a spark. 1000 V will leap few millimetres across dry air. 100 kV will leap 35 cm. Very localised point of entry creates a very high temperature causes melting of epidermal keratin which fuses into a slightly raised, hard brown nodule on cooling (the spark lesion).

Arteriolar spasm causes a surrounding areola of skin blanching around the central blister. The peripheral zone outside the blanched area may be hyperaemic. Lesion may thus appear as Blister-Redness-Pallor-Redness from centre outwards. Smaller marks may appear as tiny white discs (epidermal split with no pallor or hyperaemia)

Prolonged contact with domestic supply (usually after death) may cause severe burning with a wide area of epidermal peeling, hyperaemia and deep charring and cooking of muscle.

High voltage transmission cables may cause similar deep burns or multifocal spark lesions (crocodile skin).

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