

Lecture Notes

Wounds



Definitions

Classification of Wounds:

- Bruises
- Abrasions
- Lacerations
- Incisions
- Penetrating wounds

Kicks, Bites

Interpretation of Wound Pattern

Bruises

Stabs

WOUNDS

A **wound** is a "disruption of the continuity of tissues produced by external mechanical force" (from the old English wund and the old Norse und). There is no statutory definition of a wound but some English case law developed in relation to the offence of "wounding". This case law is to the effect that to constitute a wound there must be a breach of the full thickness of the skin involving both the epidermis and the dermis (R. v. Wood, 1830; R. v. M'Loughlin, 1838); it is also a wound if the inner lining of the lip is broken (R. v. Smith, 1837; R. v. Warman, 1846). By this definition bruises and abrasions are not wounds, and neither are internal injuries such as fractures, contusions of the brain and lacerations of the viscera. Consequently, this legal definition is not accepted in medical practice.

The term **injury** is used synonymously with wound, but can have a wider meaning and encompass not only damage produced by physical force, but also damage produced by heat, cold, chemicals, electricity and radiation. An injury is "a hurt, or damage to the body" (from the Latin injuria; in, not and jus, the law).

The term **lesion** originally meant an injury but it has now come to be more widely applied to include "any area of injury, disease, or local degeneration in a tissue causing a change in its function or structure" (from the Latin laesio, a hurt).

Wounds may be classified as follows:

1. **bruises (or contusions or ecchymoses)**
2. **abrasions (or grazes or scratches)**
3. **lacerations**
4. **incised wounds**
5. **puncture (or stab) wounds**
6. **gunshot wounds**

A **bruise** is "a haemorrhage into tissues produced by the escape of blood from blood vessels". Bruises may be found in the skin, muscles, and internal organs. A simple bruise of the skin, not associated with any other type of wound, is "a haemorrhage beneath the skin producing discolouration without any associated break in the skin surface". A bruise to the skin of a person is directly analagous with a bruise to a fruit (from the old English brysan, to crush, and the old French bruser, to break). The word contusion is synonymous with bruise (from the Latin contundere, to thump). Ecchymosis (plural ecchymoses) is another synonym for bruise (from the Greek ek, out of, and chymos, juice). Haemorrhage or bleeding is "the escape of blood from any part of the vascular system" (from the Greek haima, blood, and rhegnymei, to gush). Haemorrhage or bleeding is the process which produces a bruise in tissues, but the term haemorrhage also encompasses bleeding which may not be associated with bruising, e.g. a bleeding nose, or a bleeding stomach ulcer. Very small haemorrhages (ranging in size from a pinpoint to a pinhead), which occur in tissues, may be described as petechia, or petechial haemorrhages (from the Italian petecchia, which has the Latinised plural petechiae). These haemorrhages may also be described as punctate (from the Latin punctum, a point).

An **abrasion** is "a portion of body surface from which the skin or mucous membrane has been removed by rubbing" (from the Latin ab, from, and radere, to scrape). Graze is synonymous with abrasion (the etymology of graze is dubious). A scratch is a linear abrasion produced by drawing a sharp point over the surface.

A **laceration** is "a tear in the tissues" (from the Latin lacerare, to tear). The botanical term lacerate, means having irregular edges. An incised wound is "a cut or gash" (from the Latin incidere; in, into, and caedere, to cut). The incisor tooth, or fore-tooth is a cutting tooth.

A **puncture** is "a small hole made with a sharp point". Similarly a stab is "a piercing made by driving in a pointed object". A perforating stab wound is one which passes through the whole thickness of a tissue or organ (from the Latin perforare; per, through, and forare, to bore). Perforation is synonymous with transfixion (from the Latin trans, across, and figere, to fix). A penetrating wound is one which enters, but does not pass through an organ or tissue (from the Latin penetrare, to penetrate).

BRUISES (CONTUSIONS)

More [detailed description](#) below

Rupture of blood vessels with bleeding into tissues

Problems with Skin Bruises

1. Delayed appearance
2. Ageing (relative)
3. Site of Trauma
4. Shape of object
5. Degree of force
6. Post-mortem bruises
7. Post-mortem lividity

Classic Examples

- Finger pad bruises: battered babies, manual strangulation
- Different ages: repeated assaults

- Shoulders and arms: forceful restraint
- Wrists and ankles: dragging
- Inner thighs: forceful intercourse
- Chest: resuscitation

Bruising is uncommon in Suicides

Bruising in Deep Tissue

1. Possibly life-threatening
2. Sometimes no external injury

ABRASIONS (GRAZES, SCRATCHES, BRUSH BURNS)

Loss/crushing of outer skin layer due to impact with a rough surface

1. Tangential impact produces a moving abrasion:

- Indicates direction.
- Trace material (e.g. grit).

2. Direct impact produces an imprint abrasion:

- Pattern of causative object.

All abrasions reflect site of impact (contrast bruises).

Assessment of age difficult.

Post-mortem abrasion - Brown, leathery.

LACERATIONS (TEARS, SPLITS)

Splitting of the skin by the direct crushing of blunt trauma.

Typically over bone, e.g. scalp, eyebrow, cheekbone.

Distinguished from incised wounds by:

1. Adjacent abrasion/bruise

2. Ragged edge

3. Tissue bridges in depth

Forensic Importance

1. Not related to object shape
2. Trace evidence
3. Relatively little blood loss (except scalp)
4. Rarely suicidal

Typical Examples

- Stellate pattern from poker end
- Circles/crescents from hammer
- Y-shaped from metal rod

- Inside lips from blow to mouth.
 - Stretching lacerations in vehicular accidents.
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INCISED WOUNDS (CUTS)

Breach of the full thickness of the skin due to contact with a sharp edge

Forensic Importance

1. Reflects sharp edge not weapon type
2. No trace evidence
3. Bleeds profusely
4. Haemorrhage and air embolism

Direction of cut: deeper at the start

Suicidal or Homicidal?

- Site, e.g. neck, wrist, face
 - Tentative wounds - suicide
 - Defence wounds - homicide.
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PENETRATING WOUNDS (PUNCTURE WOUNDS)

Breach in full skin thickness and depth is greater than length

Long, thin, sharp or blunt object.

If sharp object then equals "stab wound". More [detailed description](#) below

Forensic Importance

1. Haemorrhage internal rather than external
2. Weapon size/shape
 - (a) Double or single edged blade: ellipse or "fish tailing"
 - (b) Blade width: wound length (beware rocking)
 - (c) Blade length: deepest wound (beware partial thrust and tissue compression)
3. Force - sharpness of tip - bone or cartilage?

Patterns

Homicide: multiple, defence wounds, scattered, different directions, same force, several potentially fatal.

Suicide: multiple, elective sites, grouped, tentative wounds, not clothing, one fatal.

Single wounds

- Accident/homicide/suicide?
 - Position/direction of wound
 - **Scene very important**
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KICKING ASSAULTS ("THE SHOD FOOT")

Gangs, individuals without weapons

Target areas - chin, neck, ears, groin, kidneys
Bruises, abrasions, lacerations - patterns
Internal haemorrhage - unusually severe
Blood group victim - very important

BITE MARKS

Double crescent of abrasions and bruises
Early Examination, loss of definition
Swab for saliva, photograph
Comparative value
Child abuse, sexual assault.

INTERPRETATION OF WOUND PATTERNS

Common Questions

1. ?Causative object or weapon -

Imprint type abrasions
Trace material in lacerations
Stabbing weapon

2. ?Manner of infliction

History and scene of death

Self-inflicted

- Incised or stab wounds
- Target sites
- Parallel, same direction
- Tentative wounds
- Accessible sites
- Scars.

Assault

- Any type of wound, combinations
- Scattered, multiple directions, uniform force
- Defence injuries
- Several potentially lethal
- Clothing
- Secondary injuries

Accidental

- Any area, single, clothing
- Defence injuries
- Secondary injuries
- Check history (suicide attempts, assaults)

?Blood spatter

- Bruises and abrasions, none

- Lacerations, not much
- Incised and stab wounds, often profuse.

?Order of infliction

- Tentative or scattered first
- Fatal and grouped last
- Distant shots before close shots.

BRUISES

Bruises (synonyms: contusions, ecchymoses) are areas of tissue discolouration produced by haemorrhage from ruptured blood vessels.

Bruises can be confined to the deep tissues and therefore not visible on the skin surface; the discussion following relates to bruising of the skin and subcutaneous tissues which is apparent from examination of the skin surface.

Bruises are typically produced by a blunt force impact, such as a blow or a fall; they may also be produced by squeezing or pinching, where the force is applied gradually and then maintained; "love-bites" are superficial bruises produced by the negative pressure of mouth suction. Bruises may occur in a variety of natural diseases in which there is an abnormality of the clotting mechanism of the blood, e.g. scurvy (vitamin C deficiency), leukaemia, alcoholic liver disease; such bruising is said to occur "spontaneously" because the injury which produces it is so insignificant as to typically pass unnoticed. The presence of such natural disease will exaggerate the bruising effects of any trauma. Florid spontaneous bruising (purpura) may be seen in children with fulminating meningococcaemia.

In an uncomplicated bruise there is no breach in the skin surface; however, bruises may be associated with other blunt force injuries such as abrasions and lacerations. As a general rule bruising is not associated with incised wounds or stab wounds where there is a free flow of blood from the cut blood vessels rather than extravasation into the tissues. Generally, the extent of bruising is inversely proportional to the sharpness of the impacting object.

The blood vessels ruptured are typically the capillaries and small veins rather than arteries. After the impact bleeding may continue for some time under the circulatory pressure of the blood. If the volume of haemorrhage is sufficient a swelling may result; if the extravasated blood collects as a discreet tumour-like pool, the lesion is referred to as a haematoma.

Site of Trauma

By contrast with abrasions, the location of a bruise does not necessarily reflect the precise point of injury. Extravasated blood will follow the path of least resistance and seep along natural or traumatic planes of cleavage of the tissues under the influence of gravity and body movements. For example, in the elderly, intense and widespread bruising of the outer aspect of the lower thigh may follow a fracture of the hip; a bruise of the temple may gravitate down to the cheek; a fractured jaw may result in bruising appearing on the neck.

Delayed Appearance

Gravitational shifting of deep bruises may result in their appearance at the skin surface being delayed. The more superficial the source of bleeding, the sooner the discolouration will be apparent on the skin surface. Deep bruises may require as long as 12 or 24 hours to become apparent and some may never do so. In a living victim, a second examination after an interval of one or two days may disclose bruising where previously there had been only swelling or tenderness on pressure. Similarly, in the dead, a further examination one or two days after the

original autopsy may disclose bruises which were not previously evident as well as revealing more distinctly bruises which previously appeared faint. This may be particularly the case with "fingerpad bruises" produced by handgrips. Ultraviolet (UV) light may disclose bruises which are not otherwise identifiable at the time of examination.

Degree of Force

The size of a bruise is an unreliable indicator of the degree of force causing it. In general a heavy impact is likely to produce a large bruise and a light impact to produce a small bruise. If bruising is slight then it is reasonable to assume, unless the contrary is clear from other findings, that the degree of violence was slight.

In assessing the degree of violence from the appearance of bruises, several factors must be taken into consideration:

(a) Location:

Some areas of the body bruise more easily than others, e.g. the face with its vascular and more abundant lax subcutaneous tissues bruises more readily than the hands. Bruising occurs more readily in loose tissues, e.g. around the eyes and genitals and where there is a large amount of subcutaneous fat, e.g. buttocks and thighs, but less easily where the skin is strongly supported by fibrous tissue, e.g. palms, soles and scalp, or if the muscle tone is good, e.g. abdominal wall of boxers.

(b) Age:

Infants and the elderly tend to bruise more easily than young and middle aged adults; the former because of the looseness and delicacy of the skin, and the abundant subcutaneous fat; the latter because of degenerative changes in the tissues which support the small blood vessels of the skin and subcutaneous tissues.

(c) Sex:

Women bruise more easily than men because they have more subcutaneous fat and this is particularly true of obese women.

(d) Natural Disease:

Individuals with diseases affecting the blood clotting mechanism (see above) e.g. chronic alcoholics, tend to bruise more easily, as do individuals with degenerative disease of the blood vessels and high blood pressure. Bruises may also heal more slowly in these individuals.

(e) Skin colour:

This does not modify the extent of bruising but does influence the appearance. Bruising is more easily seen in blondes and redheads than in more swarthy persons; in blacks extensive bruising can be completely masked by the natural skin colour.

Causative Object

Bruises tend not to reflect accurately the shape of the causative object because the bruise tends to change its shape and location with time under the influence of the factors enumerated above. The shape of the bruise is most likely to reflect the shape of the causative object when the object is small and hard and death supervenes soon after injury (limiting the extension of the bruise normally produced by the pressure of blood in the circulation).

A doughnut bruise is produced by an object with a rounded contour, e.g. cricket ball. Two parallel linear bruises ("tramline bruises") result from a blow with a rod or stick; the pressure of the blow from the rod displaces blood to the sides to produce the bruises on either side of the line of impact. If the blow with the rod is struck against the buttocks, - a particularly pliable,

curved, soft surface - the tissues are compressed and flattened under the impact; the resulting bruise will follow the curved contour of the buttocks. A pliable weapon such as a strap or electric flex may produce a similar appearance as it wraps around the body on impact.

Bruises produced by fingerpads as a result of gripping are usually larger than the fingerpads themselves, but their pattern and location suggests the mechanism of causation, e.g. on the neck in throttling and on the upper arms in restraint.

A bruise which bears the imprint of the shape or contour of the impacting object is said to be patterned. With patterned bruises, a tracing of the pattern may be made to match to the causative object, or photographs of the injury and object may be superimposed. Patterned bruises of this type may be associated with patterned (imprint) abrasions. Examples of patterned bruises may be seen from ligatures around the neck in strangulation; the headlight, grill or bumper of a vehicle impacting a pedestrian; and the muzzle or foresight of a gun in contact gunshot wounds.

Occasionally clothing or jewellery may leave a patterned bruise on a body when it is crushed into the skin surface by an impacting object, e.g. motor vehicle striking a pedestrian, or a kick through clothing.

Ageing of Bruises

Immediately after infliction a bruise will be dark red, the colour of capillary blood, turning fairly soon to a dusky purple; the bruise succeedingly appears brown, green and yellow before finally fading away from a pale straw colour. The colour changes progress from the periphery of the bruise towards the centre. The majority of bruises have disappeared within one to four weeks of infliction, but this time frame is extremely variable depending upon the size and depth of the bruise, its location and the general health of the individual. In general a green discolouration appears after four to five days or later, a distinctly yellow change after seven to ten days or later, the final disappearance of the bruise occurs in fourteen to fifteen days. "Love bites" which are small and superficial, typically complete this sequence in seven days. While accurate estimation of the age of a single bruise is not possible, a fresh bruise can be distinguished easily from one which is several days old. Establishing that bruises are of different ages may be of medical importance where there is an allegation of repeated assaults, e.g. child abuse and wife battering, or where pre-existing injuries need to be distinguished from those produced by a recent assault, e.g. a chronic alcoholic who was assaulted. A patterned bruise with a sharply defined outline infers that death occurred shortly after infliction, for otherwise the bruise would be less well defined. It is not possible to distinguish a bruise sustained at the time of death from one which occurred some minutes earlier; such bruises are best described as having occurred at or about the time of death.

Post Mortem Bruises

Bruising is essentially a vital phenomenon in which the extravasation of blood into the tissues occurs under the pressure of the circulating blood. After death the rupture of blood vessels as a result of blunt force impact may lead to the extravasation of blood. For so long as fluid blood is present in the capillaries and veins, any injury that crushes these vessels will allow blood to extravasate into the surrounding tissues. However, the extent of blood spread is limited since the pressure of blood within the vessels is only physical. In practice it requires considerable violence to produce a bruise post mortem; the bruise is invariably disproportionately small relative to the degree of force used. Such post mortem bruises are most readily produced in areas of hypostasis (post mortem lividity, livor mortis) or where tissues can be forcibly compressed against bone, e.g. over the occiput. In practice post mortem bruising is unlikely to be confused with ante mortem injury except perhaps in the case of occipital bruises where a lesion an inch in diameter may be produced by careless handling of the body during removal from a scene of death or in the mortuary. In assessing the possibility that bruising may be post mortem,

consideration must be given to the findings and circumstances as a whole; against this background quantitative differences between ante mortem and post mortem bruises are usually so great that confusion is unlikely. It is seldom difficult to distinguish between injuries with vital bruising resulting from a vehicle running over a live body, and the tearing and crushing of dead tissues.

Post Mortem Lividity

Post mortem lividity (synonyms: hypostasis, livor mortis) is the settling, after death, of blood within the blood vessels under the influence of gravity. This results in a purplish discolouration of dependent parts of the body with sparing of areas of pressure contact - contact pallor. The pattern and distribution of lividity distinguishes it from bruising. In doubtful cases incision of the skin will disclose blood oozing from the cut ends of vessels in instances of hypostasis, in contrast to extravasated blood within the tissues in bruises. Washing of the cut surface with running water will remove the blood from hypostasis but not the blood infiltrating the tissues in bruises. Confirmation of the distinction may be made by microscopic examination.

Post mortem decomposition with its initial green discolouration of the anterior abdominal wall is readily distinguished from bruising. Putrefactive haemolysis of blood within the vessels and decompositional breakdown of the vessel walls results in extravasation and diffusion of haemolysed blood into the adjacent tissues; existing bruises are enlarged by this process; later, putrefactive haemolytic staining of tissue may mask ante mortem bruising, e.g. in the neck muscles in cases of throttling.

Deep Bruises

Bruises of the deep tissues, even when fatal, may not be evidenced by any injury to the skin surface. Fatal head injuries, e.g. subdural haemotoma, may be encountered without recognisable superficial bruising. Fatal strangulation with extensive bruising of the muscles of the neck may be accomplished without obvious bruising of the skin. Blows to the abdomen, although producing ruptures of internal organs, may not produce any external bruising. Bruising is more likely to be confined to deep structures and spare the skin surface when produced by blows with a wide and smooth object.

Focal necrosis of subcutaneous fat may occur at the site of a bruise; secondary aseptic inflammation in response to the irritant effect of fat liberated from the ruptured cells produces a hard chronic lesion. This is more of medical than forensic importance as a common site is the breast where it may be mistaken for a carcinoma.

Classical Examples

Bruises on the neck raise the suspicion of throttling, particularly if the bruises are round or oval and approximately fingerpad size. Similar fingerpad-type bruising from gripping may be seen on the limbs of battered babies, e.g. gripping the arms or legs to forcibly swing the child or twist the limbs, or on the cheeks, in forceful gripping of the face, or on the trunk, bilaterally, in forceful shaking. Fingerpad-type bruises on the upper arms near the armpits suggests forceful restraint but may also be seen when an unconscious or semi-conscious person is lifted by persons rendering assistance. Fingerpad bruising of the thighs of a woman suggests forceful intercourse and may corroborate an allegation of rape. These bruises in themselves would be medically inconsequential, but are of considerable medico-legal significance since they constitute objective evidence, from their location and pattern, which can corroborate an allegation of assault.

Bruises to the knuckles of the hands, together with bruises of the eyelids, bridge of the nose, cheeks and lips, are suggestive of a fist fight. Bruising around the eyes - so-called spectacle haemotomae - may be produced by direct blows, but also commonly result from a fracture of the base of the skull, e.g. in vehicle collisions or gunshot wounds to the head; they may also follow blunt impact to the forehead producing jolting of the eyeballs in their sockets with tearing of

small orbital blood vessels.

Bruising of the genitalia and around the anus suggests sexual assault. Severe bruising of the genitalia, with or without laceration, can be produced by kicks.

Counter-pressure bruising, with or without abrasion, to the bony prominences of the back, i.e. the shoulderblades, sacrum and pelvis, suggests pressure against a firm surface as in forceful restraint on the ground, e.g. in rape or throttling. Similar bruising may be seen on bony prominences of the front of the pelvis in attempted anal rape.

Elipitcal bruises, up to 1" long and up to 3/4" broad on the sides of the neck or the breasts, suggests "love-bites" produced by mouth suction. (A "hickey" in American slang). A double crescent of bruises with or without abrasions, suggests a bite mark and is most commonly associated with sexual assault or child abuse.

In kicking assaults with the shod foot bruises are invariably associated with multiple abrasions and lacerations. The bruises and abrasions may be patterned by the boot. Bruising is typically extensive and targeted on the face, neck, ears, groin, and kidney area. Internal bruising is usually severe.

Bruising of different ages may suggest repeated assaults, e.g. child abuse and wife battering. Multiple bruises of different ages are also seen in individuals who have natural disease affecting blood clotting and/or sustain repeated falls, e.g. chronic alcoholics, and elderly persons with poor balance. Bruises of different ages scattered on the forearms are often seen in the elderly.

Bruising of the anterior chest may be produced during attempted resuscitation by medical personnel and others. During hospitalisation bruises are commonly produced by multiple needle punctures, and occasionally pinching the person to test the degree of loss of consciousness.

Bruises are painful and therefore not commonly self-inflicted; extensive bruising creates a presumption of assault. Accidents generally are unforeseen and the injuries they produce tend not to follow a recognizable pattern; however, some accidents are sufficiently stereotyped and common as to produce patterns e.g. bruises on the shins of young children from play, falls and walking into objects, and bruises on the hips of women from bumping into drawers, cupboards and other objects about the home. Injuries in motor vehicle collisions almost invariably include abrasions and lacerations as well as bruises; patterns of injury may allow reconstruction of incidents involving pedestrians or allow distinction between driver and front seat passenger.

STAB WOUNDS

Stab wounds or puncture wounds are penetrating injuries whose depth within the body is much greater than the dimensions of the wound on the body surface. They are essentially percutaneous injuries. They can be produced by any long thin object which impacts the body with sufficient force to penetrate. The typical instrument is a knife, but any sharp pointed, or keen-edged object will suffice, e.g. a screw driver, skewer, hypodermic needle, ice pick, fragments of glass, metal, or wood, protruding parts of machinery or motor vehicles, and broken ends of bones (as in puncture wounds of the lungs from fractured ribs). The method of infliction includes not only thrusts with a weapon, but also falling upon pointed objects.

A wound which passes completely through a structure (such as the heart) is described in North America as "perforating" or "passing through and through" the structure, but in Britain is usually described as "transfixing". "Perforating" is a term used more loosely in Britain, often as a synonym for penetration. In North America "penetrating" refers to a wound track which enters a structure but does not exit it, i.e. does not pass completely through the structure.

Objects producing stab wounds fall into three general categories, namely (a) those which are flat with a sharp point, e.g. a knife, (b) those that are long and thin with a sharp point, e.g. a hat pin or needle, and (c) those long rigid objects which are blunt ended, e.g. a wooden stake.

Wound Descriptors

In addition to a description of damage to the clothing, reports on stab wounds should include the following information on each wound:

Site: relative to local anatomical landmarks as well as its distance from the midline and above the heel (or below the crown of the head).

Shape and Size: including the dimensions with the wound edges reapposed.

Direction: approximately, in three dimensions.

Depth: of the wound track at autopsy.

Damage: to tissues and organs along the wound track.

Effects: of damage described above, e.g. haemorrhage, pneumothorax, air embolism.

Wound Characteristics

If a stabbing with a knife is "straight in and out" then the length of the stab wound on the skin surface is typically slightly less than the width of the blade, due to the elastic recoil of the skin following withdrawal of the weapon. This effect is exaggerated by the tendency of the wound to gape open so that the wound becomes wider but shorter; the extent of gaping reflects the alignment of the wound relative to natural lines of tension within the skin - Langer's lines. Wounds with their long axis parallel with Langer's lines tend to gape only slightly, whereas wounds aligned at right angles to Langer's lines tend to gape widely. The extent of wound gaping is also influenced by damage to underlying fascia and muscles. Consequently, the length of a stab wound on the skin surface should be measured after the gaping edges have been approximated (using transparent tape), thus re-establishing the anatomical relationship of the skin edges that existed prior to injury.

The length of the wound on the skin surface may give a false impression of the true width of the weapon blade if (a) the blade has a marked taper and the entire length of the blade has not passed through the skin, i.e. a "shallow" stab, or (b) the blade has not passed "straight in and out" but instead there has been "rocking" of the blade, or it has been withdrawn at a different angle or plane to the original thrust. Consequently, the most reliable assessment of blade width is made from the deepest wound with the shortest skin surface length.

A knife blade with a double edge will normally produce a symmetrical elliptical wound with both ends pointed; a knife with a single-edged blade may show relative blunting ("fish-tailing") of one end of the entry slit. However, a single edged blade can produce a wound with two pointed ends, mimicking an injury from a double edged blade. A bayonet, which has a ridge along the back of the blade with a groove along each side, may produce a slit like an elongated letter "T".

The cross-section of the blade may be accurately reproduced when the blade passes through bone, e.g. skull or sternum. Stab wounds of the liver may be filled with radiopaque contrast material and an X-ray taken showing the profile of the wound track which, in a straight in and out stab, will reflect the profile of the blade.

If the blade enters the skin obliquely then one edge will be bevelled and the opposing edge will overhang, i.e. be undercut; this gives an indication of the direction of the underlying wound track. Withdrawal of the knife blade in a slightly different direction from the entry thrust may

produce a notch along one edge of the wound; marked twisting of the blade (or twisting of the body) may exaggerate the notch effect, resulting in a cruciate wound.

Typically stab wounds produced by knives are elliptical with clean cut edges and without any associated bruising or marginal abrasion. A knife which is driven into the tissues with considerable force may produce bruising or abrasion of the wound edge by the hilt of the weapon; this is an uncommon occurrence.

Stab wounds produced with relatively blunt instruments such as pokers, closed scissors and files, tend to bruise and abrade the wound margin. These blunter instruments also tend to lacerate, as well as cleanly penetrate, the skin; the blunter the point of the instrument and the thicker its shaft, the more likely is the entry hole to become a ragged, often cruciate split. Where an instrument has a varied cross-sectional shape along its length, e.g. a screw driver, the depth of penetration may affect the appearance of the hole. Stabs from an instrument which is square in cross-section result in cruciate wounds in the skin. The prongs of a hay fork which are circular in

cross-section produce small elliptical wounds; an ice pick, which has a thin circular shaft, produces a round hole or slit; a triangular file produces a three-cornered wound. Whenever practicable, it is wise to conduct experiments with a duplicate of an alleged weapon in order to determine the appearance of the wounds it can produce.

Degree of Force

It is easy to over-estimate the amount of force required to produce a stab wound. The most critical factor is the sharpness of the point of the instrument; relatively little force is required to produce a stab wound provided a knife with a sharp point. After clothing, the skin offers the greatest resistance to penetration; once this is overcome, then the blade slips into the deeper tissues with considerable ease (an analogy might be made with the stabbing of a ripe melon). The penetration of bone implies the application of a significant degree of force, e.g. ribs, or sternum; the tip of the blade may break off when driven into bone and should be recovered for matching with the weapon. In addition to the assessment of the force exerted by an assailant, consideration should be given to the possibility of counter pressure by the victim, e.g. running or falling forwards. The depth of a wound is not generally an indication of the degree of force used (but see below).

Wound Depth

The depth of the wound, i.e. the length of the wound track, provides some indication of the length of the stabbing instrument. The wound track length may be less than the length of the instrument if the weapon was not thrust into the body to the limit of its length, e.g. a stab wound from a knife with only half the length of the blade entering the body. Conversely, if the thrust is forceful, not only may the entire length of the blade enter the body but the tissues may be compressed, so that when the weapon is withdrawn the resulting wound track in the decompressed tissues is longer than the blade of the weapon; in this manner, the blade of a small pocket knife, a few inches long, can produce an abdominal stab wound which penetrates the aorta, or a chest wound which penetrates the heart. Compression of the body by a forceful stab is most pronounced in abdominal and chest wounds but occurs to a lesser extent with any soft tissue (muscle and fat).

An additional complicating factor is that the post mortem examination of a body takes place with the body lying flat on its back, so that the position of the viscera will not necessarily be the same as when the person was standing up or sitting down during life. For these reasons the depth of penetration of a stab wound should be interpreted with caution. If some fixed bone, e.g. a vertebra, is damaged at the limit of the wound track, then assessment of depth of penetration is easier.

Depth is a specific characteristic of stab wounds; although the injury to the skin may appear trivial, the great depth of these wounds, with severing of blood vessels and penetration of viscera, characteristically results in internal haemorrhage, often with little external bleeding.

Clothing

Examination of the clothed body may yield valuable information. Cuts on the clothing should be noted and correlated with injuries to the body; more than one cut on the clothing may correspond with a single injury to the body as a result of folds in the clothing; cuts to the clothing may not exactly overlie corresponding wounds to the body, e.g. in the back of a man's jacket this may indicate that the arms were raised; there may be stab or slash marks on the clothing without corresponding injuries to the body, e.g. "defence"-type slashes to the arms. Blood flow patterns on the clothing may indicate the position of the victim at the time of the stabbing, e.g. blood drops on the tops of the shoes from a stab to the chest in a victim standing upright; or indicate subsequent movements of the body, e.g. blood flow vertically down the face and then back towards the ear in a victim stabbed in the face while sitting or standing, but subsequently coming to lie on the back.

Direction of Wound Track

This may be indicated by undercutting and bevelling of the external wound as well as being readily disclosed by dissection of the wound track at autopsy. Extrapolation from the direction of wound tracks to an opinion on the relative positions of an assailant and victim should be always guarded because two potentially moving objects are involved. It should be remembered that the position of the viscera in a corpse lying on the autopsy table differs from that in an upright living person. In wounds to the back of the shoulder, the presence or absence of involvement of the scapula may help in resolving whether the victim's arm was raised at the time. Similarly examination of the clothing may be helpful.

Manner of Death

In assessing the manner of death, the information obtained from examination of the body must be correlated with scene of death and historical data. Most deaths from stab wounds are homicidal; even in Japan, where there is a cultural tradition of suicide by stabbing, such deaths constitute less than 2% of total suicides.

Homicidal stab wounds are usually multiple, since most wounds leave the victim capable of some resistance for a measurable time during which the thrusts are repeated; single homicidal stabbings are often associated with drugged, drunk, sleeping, or otherwise partially incapacitated victims and are almost always aimed at the heart. The location and number of wounds may suggest homicide; wound directions and sites inaccessible to the victim imply homicide; multiple scattered widely spaced wounds most, if not all, of which have penetrated deeply (suggesting relatively uniform force), with tracks in different directions and several lethal, also suggests homicide. Homicidal stab wounds to the chest are all likely to be deep, penetrating the chest wall, and more than one may be lethal. Stabs in the back strongly suggest homicide. In cases of multiple scattered stabs, the larger the number the greater the certainty of murder; there is often a sexual motive to deaths with this type of "over-kill". Stabs from long thin weapons, e.g. 1920's style ladies hatpins, may be difficult to identify, e.g. at the skull base at the back, and possibly escape detection.

In a stabbing action by an assailant, the weapon is usually held with the point downwards so that most wounds in the victim are directed downwards; if the weapon is held with the point upwards, in a so-called "continental" manner, the wounds will be directed upwards.

"Defence wounds" are the result of the immediate and instinctive reaction of a victim to ward off anticipated injuries and may be seen in both homicidal and accidental deaths. Defence wounds in cases of homicidal stabbing result from raising the arm to ward off the attack or attempts to grasp the weapon. The resulting injuries may be stabs or slashes or both. Attempts to

grab the knife results in deep cuts to the palm of the hand and the palmar aspects of the fingers. With the hand in a gripping position the palmar skin is loose and folded so that resultant cuts appear irregular and ragged. They may be duplicated by the thrust and withdrawal of the weapon. Transfixion of the hand or arm is a type of defence wound. The absence of defence wounds does not exclude homicide since the victim may be incapable of effective defence for reasons such as surprise, loss of consciousness, incapacitation, or mechanical factors, e.g. the hands in the pockets or the coat sleeves partly off.

Suicidal stabbings tend to have certain distinctive features. The wounds, if multiple, have a location and direction accessible to the victim and are typically grouped in the precordium or the "pit" of the stomach; the wounds occupy a circumscribed area which is more restricted than that seen in homicide; a consistent direction of penetration reflects the use of one or other hand. If there are multiple wounds, there are fewer deep wounds than is seen in homicide and only one or two are lethal. Multiple wound tracks extending from the same slit in the skin reflects partial withdrawal of the weapon and further thrusts (possibly trial feelers), and favours suicide. Typically a suicidal stabbing is to the bare skin and the clothing may be removed or pulled aside to effect this. Defence wounds do not occur in suicide, although the sharpness of a knife may be tested by running the blade across the tips of the fingers. Multiple scattered wounds weighs against suicide unless there was serious mental illness. Attempted suicide by multiple stabbing may not always be effective or may prove too slow, so that the individual resorts to other means, such as hanging.

Where there is a grouping of suicidal stab wounds (typically in the area of the left lower chest, or left upper abdomen with the wound track directed upwards and to the right) the wounds are of variable depth with some barely penetrating the chest wall - so-called "tentative wounds" or "hesitation wounds". Similar shallow transverse, parallel, cuts may be seen on the flexor surfaces of the wrists in attempts at suicide by cutting the wrists, or on the neck in suicidal cut throat. Although the area of the heart is the preferred site for suicidal stabbing, occasionally the abdomen or the neck is selected. Suicide may be attempted by transfixion of the neck. Occasionally suicide is accomplished with a single stroke and the weapon may be left protruding from the wound. The hand of the decedent may be gripping the weapon in cadaveric spasm; this is proof that the victim was holding the weapon at the time of death and therefore creates a presumption, but not a proof, of suicide.

An accident is the result of some unforeseen, unplanned action, and any pattern of injury may result. Such wounds may be produced by knives, but also in accidents involving the shattering of glass, the splintering of wood, or in industrial and road traffic accidents. Non-fatal accidental stabbings may occur by driving tools, such as a garden fork, through the foot, needle punctures from drug paraphernalia abandoned by addicts and stepping barefoot on broken glass on the beach. A butcher or a cook may let slip a knife during carving so that the implement stabs the lower abdomen or groin. Individuals herding cattle or bullfighting may be gored by the horn of an animal. Punctures due to snake bites also fall into this category of injury.

Interpretation of the manner of death in fatalities from a single stab wound can be difficult and such a wound may be homicidal, suicidal, or accidental. The autopsy findings should always be interpreted in the light of information concerning the circumstances and scene of death. If the stab wound was inflicted during a fight then the usual defence is that it was accidental, the victim having ran or fallen on to the weapon; the position and direction of the wound may help resolve the issue.

Effects of Stabbing

The victim of a fatal stab wound may not at first be aware of the wound and may not show any symptoms or signs of injury for minutes or hours; there may be little or no bleeding on to the skin surface. The principal fatal complication of a stab wound is haemorrhage which is characteristically internal. Air embolism is a less common, immediately fatal, complication and

infection is a late complication, occurring after many days or weeks.

A lethal injury may lie beneath the most trivial-looking skin wound.

The immediate effects of stabbing, namely, shock and haemorrhage, will ultimately incapacitate the victim; however, it is exceedingly difficult, if not impossible, to say, even after examining the wound, how long consciousness would remain, how long some voluntary movement could be made, and when death would have been likely to have occurred. For example, the popular idea that with a wound of the heart the victim will almost literally fall down dead, is not sound. Any opinion should be given with caution and qualified as a "likely time", rather than an absolute; the circumstances may help in the evaluation of the medical findings. Air embolism can result in very rapid collapse and death; if the pericardium is distended with blood then death will usually have been rapid. Traumatic shock is not pronounced in stab wounds since they are inflicted with only a moderate degree of violence; the principal factor is haemorrhage.

Chest wounds implicating the heart comprise about 25% of fatal stab wounds. All stabs to the heart are serious but their gravity is significantly influenced by the site of penetration of the heart. Stab wounds to the thick-walled left ventricle may partially or completely close off as a result of muscular contraction, and haemorrhage from such wounds may be surprisingly slow; by contrast, stabs to the right ventricle and particularly the auricles usually result in fatal haemorrhage; the severing of a coronary artery increases the likelihood of a fatal outcome and a rapid death. If the perforation to the pericardial sac does not communicate with the pleural cavities, or is too small to allow easy escape of blood, rapid death from cardiac tamponade may result; at autopsy the pericardial sac contains between 200 and 450 ml of blood in cases of tamponade. Stab wounds to the heart can be closed surgically and a few undergo spontaneous healing. If the wound to the heart is massive, then the victim will collapse in seconds rather than minutes. Conversely, if bleeding is not too rapid and cardiac tamponade does not occur, the individual may be capable of vigorous activity for many minutes; death from blood loss may take anything from several minutes to a few hours.

Ten per cent of homicidal stab wounds are to the lungs; the wound track in the lung is typically associated with surrounding bruising; death usually results from haemorrhage into the corresponding chest cavity. The rate of haemorrhage, and consequently, the rapidity and likelihood of collapse and death, depends upon the size of pulmonary blood vessels penetrated by the weapon. Stab wounds to the periphery of the lung, as a rule, do not bleed profusely, and collapse of the lung may effect haemostasis; stabs involving the large vessels at the hilum of the lung may result in rapid blood loss. The chest cavity may contain from about 1 to 3 litres of blood. Escape of lung air along the wound track may produce subcutaneous emphysema as well as pneumothorax. Severing of a bronchus within the lung may result in blood being coughed up and aspirated into other parts of the bronchial tree, so that the victim may "drown in his own blood". Cerebral air embolism can result from the forcing of air from a severed bronchus into one of the pulmonary veins, so that the air is then carried into the systemic circulation.

Stab wounds to the abdomen comprise more than a third of all stab wounds. Haemorrhage from penetration of vascular organs such as the liver or spleen, or severing of large blood vessels may result in fatal profuse haemorrhage into the abdominal cavity, varying from 1 1/2 to 3 litres in volume. Stab wounds to the lower back or flank may penetrate the liver or kidneys and produce large retroperitoneal haemorrhages. Rapid and profuse haemorrhage into the abdomen usually causes the victim to collapse quickly; if the bleeding is slight, the victim may be capable of vigorous activity even in instances in which the bowel is protruding through the abdominal stab wound.

Stab wounds to the neck comprise about 10% of cases; typically the wounds are to the lower front of the neck; if inflicted by round arm swings, the wounds may be situated on the sides of the neck anywhere between the mastoid area and the clavicle. Suicidal and accidental stab wounds to the neck are uncommon. Death usually results from haemorrhage due to severing of

the carotid arteries or jugular veins or both. The rate of incapacitation depends on the rate of haemorrhage. Severing the large veins may result in a pulmonary air embolism with consequent rapid collapse.

About 5% of homicidal stab wounds are to the head. Stabs to the eye and nose area of the face, which is composed of soft tissue and thin plates of bone, may readily penetrate the brain; death usually results from haemorrhage or infection. Stabs to the thin bone of the temporal region may also result in penetration of the brain. The force required to penetrate the skull need only be moderately severe and concussion may be slight or absent. The possibility of activity by the victim must be assessed in the light of the part of the brain penetrated.

Stab wounds to the extremities are usually defence-type injuries received in a struggle. Wounds to the axilla and groin may prove rapidly fatal when a large artery or vein is severed; death results from massive external haemorrhage. These comprise about 10% of homicidal stab wounds. Partial incapacitation may result from the severing of large nerves or the injuring of a principal joint. Otherwise incapacitation reflects the rapidity and extent of blood loss.

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