# Overview to Medicolegal Aspects of Trauma(Wound Causation)

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# Wounds

# Synonyms

- Injuries
- Mechanical Injuries

# Definition

**A dissolution or disruption of the anatomical continuity of any tissues of the body**

**OR**

**Any harm whatever illegally caused to any person in body,mind,reputation,or property.**

# Mechanical Injuries

**Injuries caused by application of physical violence to the body.**

# Factors Affecting the Appearance of Wounds

## Weapon Factors

1) Type of Weapon
2) Execution of Mechanical Force
3) Weight and Velocity of the Weapon

## Tissue Factors

1) Architectural design of the Tissue
2) Resistance of the tissue
3) Movement of the Part Struck

# Type & Shape of Weapon

**This factor directly controls the shape of the wound.Examples are injuries produced with sharp,blunt and firearm weapons.**

# Execution of Mechanical Force

**It is an important factor in the interaction between weapon and a part of the body to determine the outcome.There are two manners of application of force to a part of the body.**

# Manners of Application of Force

1) Direct Application of Force
2) Indirect Application of Force

# Direct Application of Force

**This produces wound at the point of application proportionate to the extent of the force and such injuries at the site of impact are called impact injuries.Examples are injuries produced with a club,kick or brick at the site of impact.**

# Indirect Application of Force

**It results in injury at a place away from the site of impact.Stretch Laceration and deceleration injuries of the chest and cranium are examples.**

# Weight & Velocity of the Weapon

According to the laws of physics; force = ½ mv2 ,where m is the mass and v is the velocity,the damage by the latter being greater on account of its being squared.

**This means that a brick gently pressed against the scalp will cause no injury but the same brick falling from a height on to the head may smash the skull.**

# Architectural Design

**It is the construction of a part of the body with its various tissues.**

**It has a direct relationship to its behavior in response to a strike by a weapon.**

- The human body is composed of different types of tissues,which are either soft and elastic like skin,fat,muscle and internal organs or relatively rigid and less elastic like ligament and cartilage or hard,having limited elasticity like bones.
- **Elasticity of bones** depends upon the age of the person and extent of calcification.
- Bones of infants are relatively elastic than those of adults and old persons,which become brittle and thus break more easily.
- **Shape/Size of bone** may be long like those of limbs and ribs,or plate like such as vault of the skull and crest of ileum or having short irregular or peculiar shapes like small bones of hands and feet.
- These shapes along with size and density of bones have a relation to the outcome.

- Based upon the design,a part of the body may be compact as in limbs or a cavity as in abdomen,chest and cranium.
- These cavities have organs in them,which are of different shapes and consistency being composed of different types of tissues.
- Because of the design of these organs,they have different character;
  - Liver,spleen and kidney are solid
  - Lungs are spongy and contain air in them
  - Stomach,intestine,heart,gall and urinary bladder are hollow sacs having fluid or semi-solids of different density in them like blood in the heart,bile in the gall bladder,water mixed food in stomach and intestine and urine in the urinary bladder.

**An impact with a club having same force and same directions on different parts of the body having different architectural designs shall produce injuries of different shape.**

**Impact on the forehead produces a laceration,whereas similar impact on the buttock shall produce a bruise.**

**This difference in the shape and type of a wound is due to the difference in architectural design;forehead has scalp attached over a bone whereas buttock comprises mostly of soft tissues of skin,fat and muscles.Hip bones are buried deeply within.**

# Resistance of the Tissue

**It controls the outcome,which depends upon the extent of surface area involved and the ability of the part to absorb the force without damage.**

**Soft and elastic tissues like the skin and muscle absorb the striking force effectively without being injured,whereas hard and inelastic ones like bone fracture with the same force.**

# Effect of Movement of the Part Struck

- this can be appreciated by noting the differences in wound produced when the part is stationary or in motion
- The difference is best manifested when a cavity of the body like head or chest is involved
- A strike on a stationary head produces injury of the scalp at the site of impact and damage may extend eve to deeper structures including bone and brain,but no where else
- If a moving head strikes a stationary object,the resultant trauma will be combination of impact injury and a deceleration effect to the contents of the cranium at two sites involving both the membranes and the brain substance

- These injuries are due to pressure strains caused by concentration and rarefaction produced because of movement of the membranes and the brain matter
- The injury immediately below the site of impact is called **coup-injury** and another at a point diagonally opposite to the point of impact is called **contre-coup injury**.

# Fingerprints
## (DACTYLOGRAPHY)

**Most Commonly used Forensic Evidence Worldwide**

# History of Fingerprinting (The Galton System)

- In 1892 Sir Francis Galton published his observations regarding ridge, patterns of fingers in his classic textbook ***Finger Prints.***

- Sir Edward Henry in 1901 modified Galton's work and introduced it at Scotland yard. The method was thus named Henry-Galton's System for Identification.

- This method became the basis for criminal investigation and absolute identification worldwide.

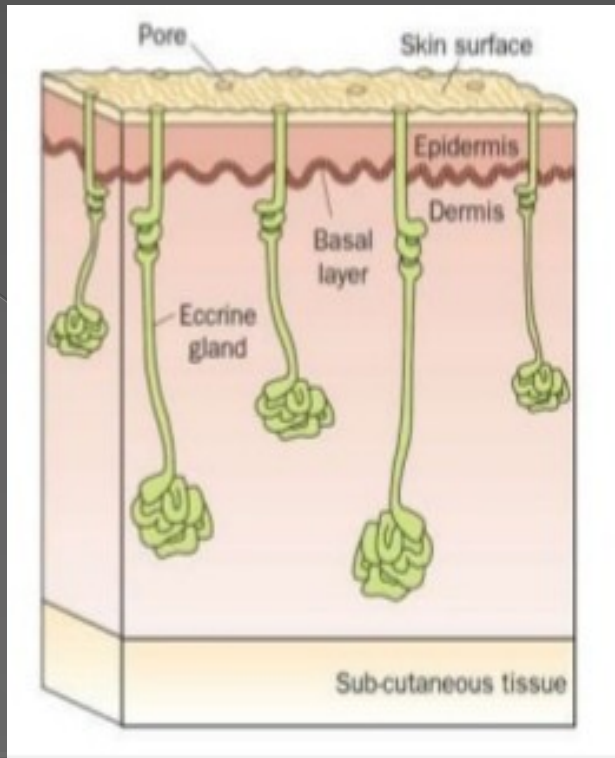
# What is Fingerprint?

An impression made by balls of a finger

- The skin of the balls of the finger and thumb is covered with ridges (raised portions) and grooves
- These grooves and ridges have a characteristic pattern which varies B/W individuals and makes absolute identification possible.

# How a Fingerprint is formed?

- When the ridges press against things and surfaces, they leave a mark
- The ridge impression are due to moistening of skin by sweat and sebum from skin glands
- Other material that can help in formation of these impression are water, oil, grease, salts, dirt, etc.



# Methods of Taking Fingerprints

- Plain fingerprint
- Rolled fingerprint

# Age of Fingerprint

**It can be estimated from the chloride content found in sebaceous secretions,the levels of which deteriorate with passage of time.**

# Medicolegal Importance

# Characteristics of Fingerprints

- A finger print is unique to an individual, no two people have been found with the exact finger print pattern. ( not even Identical twins)
- They are present from birth(4th intrauterine month)
- Present on epidermis and dermis.
- A fingerprint pattern will remain unchanged for the life of an individual unless the print itself may change due to permanent scars,destruction of true skin and skin diseases.
- Fingerprints have generic characteristics ridge patterns that allow them to be systematically identified

- The chances of two fingerprints matching sixteen ridge characteristics are infinitely small
- In the world’s crime records,no two identical fingerprint patterns have been reported
- In case of criminals,impressions of all digits of both hands are taken and preserved by police for future identification
- It is customary in the sub-continent , to take left thumb impression of illiterate persons in lieu of a signature on many legal and other documents.

# Types of Crime-Scene Prints

- Latent or Invisible Fingerprints.
- Visible Fingerprints.
- Plastic Fingerprints.

# Visible Fingerprints

**Fingers when smeared with blood,grease,etc,will leave their impression on the weapon used for crime or at the crime scene articles such as furniture that may be touched by the criminal unintentionally.**

# Latent Fingerprints

**These are faint/invisible fingerprints that the fingerprint expert can make visible by means of developing agents in the forms of liquids or powders.When these are found at the scene of crime by chance,they are called chance fingerprints.**

# Plastic Fingerprints

**Finerprints left on soft materials such as wax,soap,dust,etc.**

# Fingerprints from Dead Body

**In a dead body,if the fingerprints are dried up,the prints can be taken after soaking the fingers in an alkaline solution for sometime.**

**If the skin has peeled off as a result of burns,putrefaction,or drowning,the prints can still be recorded either from the dermis or from the peeled off skin hardened by formalin.**

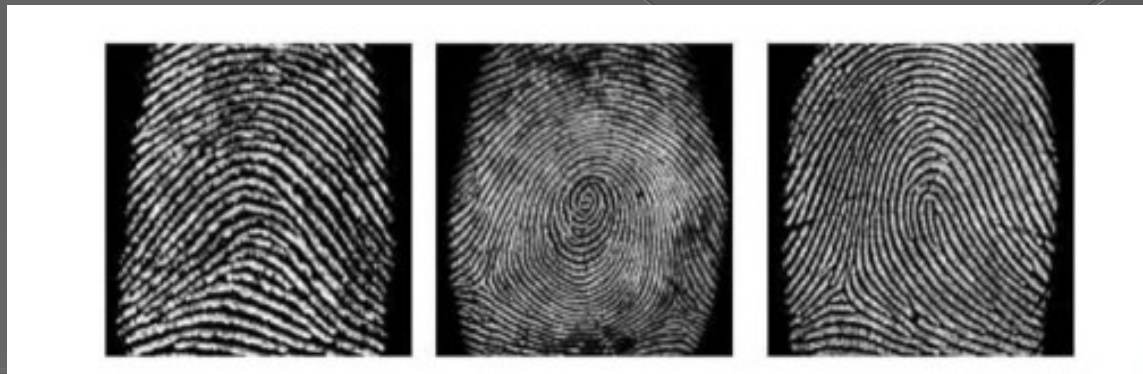
# Other Facts About Fingerprints

- At the scene of crime they are found on door knobs,furniture,weapons,and various other articles,unless the criminal has worn gloves
- Fingers soiled with blood or grease also leave appropriate impressions
- If the impressions are faint,the fingerprint expert can make them visible by special techniques such as use of dusting powder

# Classification

- **Based on the arrangement of ridges, the fingerprint patterns are classified into four types:**

1. **Loops 65% population**
2. **whorls 25 % population**
3. **arches 5% population**
4. **Composites or Compounds 2-3% population**
5. **Accidental Variety---no specific ridge pattern available**



# Advantages of Fingerprints

- Applicable to all persons of all ages
- Makes absolute identification possible
- Can be obtained from putrefied bodies
- No specialized training or expensive equipment required
- Actual print available to check errors
- Easy classification
- Can be transmitted from one place to another as a coded or digitalized message

# Poroscopy

It is the further study of finger prints described by Locard providing absolute identity.It is therefore known as **Locard's method**.

- Papillary ridges of the skin of the balls of fingers and of the hands are studded with multiple minute pores which are the openings of sweat glands situated below the epidermis.
- These pores are permanent and vary in shape ,size,position,arrangement and numbers over a given length of a ridge in each person making them ideal for establishing identity(method of identification by means of these pores is known as poroscopy).
- This method is very useful when only a part of the fingerprint or a fragmentary print is available for examination or identification.

# Practical Application

- Recognition of chance fingerprints left at the scene of crime
- Identification of the weapon used for committing suicide,homicide such as firearm weapon
- Identification of habitual criminals,sucides,deserters,persons suffering from loss of memory or those dead or unconscious after being involved in an accident
- Identification of decomposing or mummified bodies of unknown persons
- Prevention of impersonation
- As an extra precaution on cheques,bank notes,and other legal documents which may bear a fingerprint in addition to manual signature.

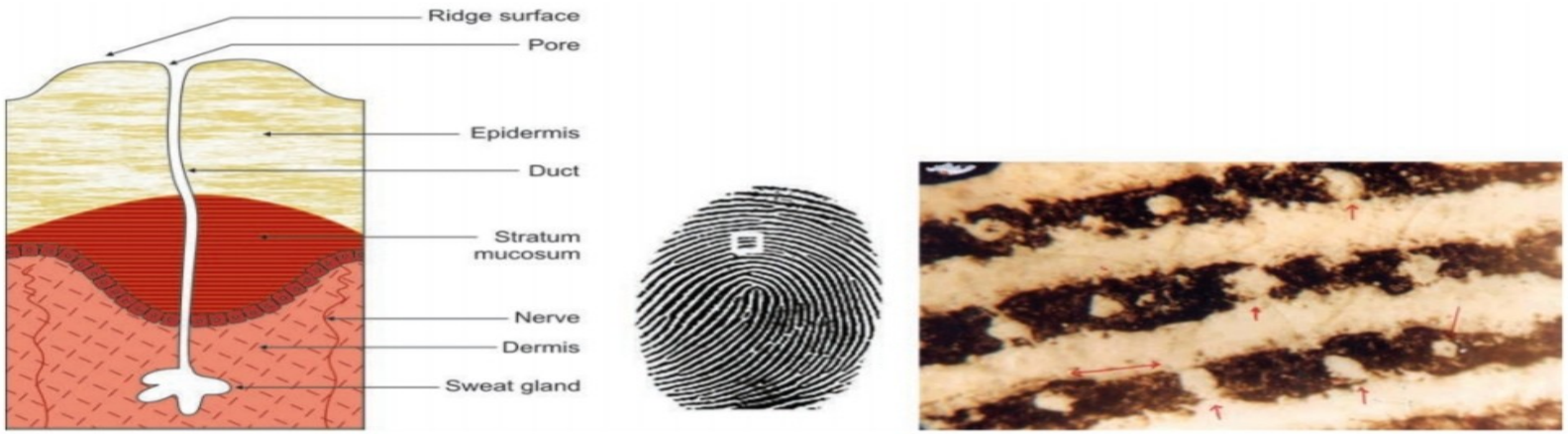



**Fig. 11.35A:** Poroscopy study: Line drawing on left side illustrating the structure of finger print ridges with pore of the sweat gland duct opening in the middle of the ridge. Finger-print with magnification of the area selected (white box) presenting pores on the ridges (Magnified view)

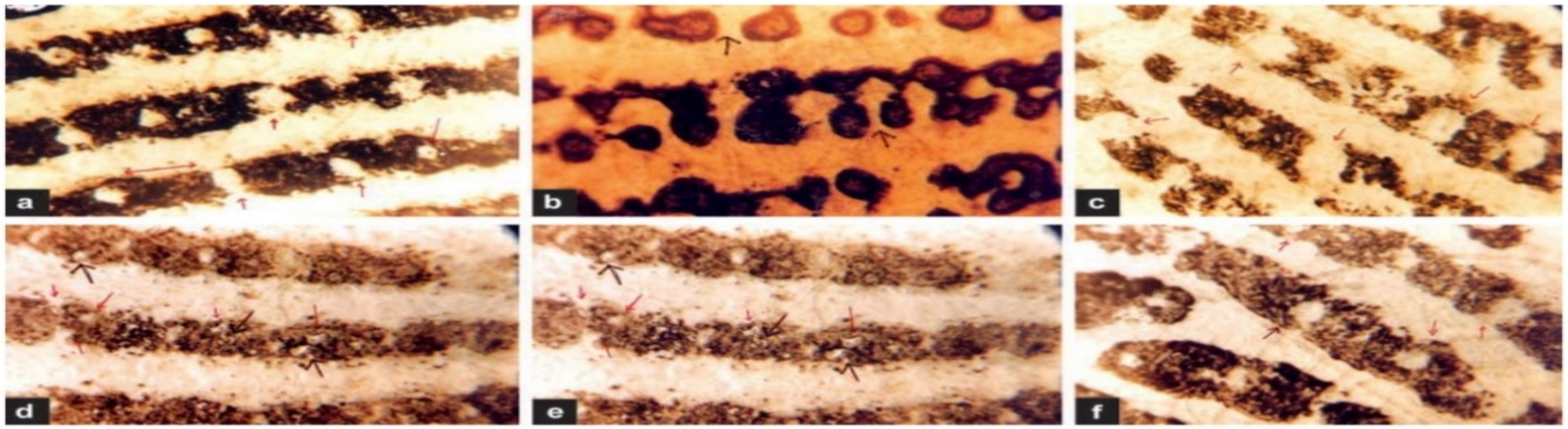



**Fig. 11.35B:** Poroscopy has been recently studied in detail, classified in to several types by *Bindra B, Jasuja OP and Singla AK* and they are*: (a) Pores of rhomboid and rectangular shape with open mouth, (b) Pores making chain type configuration, (c) Pores of large size with open mouth, (d) Pores of minute size lying in groups and very close to each other, (e) Pores located in the middle of the ridge, (f) Pores of medium size and rounded in shape

(* Bindra, B, Jasuja, OP and Singla AK. Poroscopy: a method of personal identification revisited. Anil Aggrawal's Internet Journal of Forensic Medicine and Toxicology, 2000; Vol. 1, No. 1) *Source:* http://www.geradts.com/anil/ij/vol_001_no_001/paper003.html (Retrieved on 21.07.2009)

# Acquired Peculiarities

- Occupational marks
- Tattoo marks
- Scars
- Acquired malformations/deformities(surgical wounds,amputations,multiple fracture,dental extraction,dental cavities and fillings,circumcised penis,etc)

# Tattoo Marks

These are designs effected by multiple small puncture wounds made through the skin with needles or similar penetrating tools dipped in a dye.

OR

Imprinting pigments of different colors in the dermis by multiple puncture method produces tattoo marks.

This can be done **mechanically/by electrical device**(battery operated).

It is practised all over the world and are fairly **good identification** factors,in both **living** and **dead**.


**Figs 11.48A to H:** *Tattoo marks:* (A) On low waist; (B) On the abdomen (*Source:* http://www.tao-of-tattoos.com/butterfly-tattoos.html); (C) Penile tattooing (Source: http://www.tao-of-tattoos.com/images/spider-tattoo-on-penis-21105572.jpg); (D) On the upper arm (*Courtesy:* Prof. SCAD Sapeco, Head, Dept of Forensic Medicine, Goa Medical College, Bambolim, Goa); (E) "Ohm" Tattoo on the back; (F) Tattoo of a Hindu God on forearm (*Courtesy:* Dr Tanuj Kanchan, Asst. professor Dept. of Forensic Medicine, KMC, Mangalore); (G) Design tattoo on forearm; (H) Whole body tattooing (*Source:* http://cajunboyinthecity.blogspot.com/2007_09_01_archive.html)

# Pigments Used in Tattooing

- **Carbon dust**
- **Indian ink**
- **Indigo**
- **Chinese black**
- **Prussian blue**
- **Cinnabar**
- **Cobalt**
- **Vermillion**

Chemical content of different color pigments used for tattooing are;

*Red pigment ----- Mercury

*Yellow pigment ---- Cadmium

*Green pigment ----- Chromium

*Blue pigment ------ Cobalt

# Permanency of Tattoo Marks

It depends upon

1) Type of dye used
2) The depth of its penetration;and
3) The part of the body tattooed

Black,blue and red dyes are more durable,almost permanent.

The optimum depth of penetration is up to the superficial layers of the dermis.

Tattoo marks are permanent and stay life life long if the pigments are placed in the dermis and on covered parts of the body.

# How to Reveal Latent Tattoo Designs

Latent tattoo marks can be revealed using;

- **High-contrast photography**
- **Computer image enhancement**
- **Ultraviolet lamp**;or
- **Infra-red photography**
- **By rubbing suspected area and using magnifying glass**

Tattoo marks on unidentified putrefied bodies may be photographed with sharp definition if the loose epidermis is first removed and the design on the dermis recorded.This method is of special value in the case of bodies recovered from water.

A tattoo mark described by relatives which is absent at autopsy may lead to a mistaken identification unless it is remembered that lymph nodes in the neighbourhood of a tattoo mark always show a deposit of the pigment used.

# Diversity of Tattoo Marks

Tattoo marks have a great diversity.Tattoo marks mostly represent;

- Personal details
- Details of favourites/beloved/lover/friend/relatives/pets,place of living,religious beliefs,sexual fantasies,etc

# Alteration of Tattoo Marks

Alteration of a tattoo mark is possible by over tattooing with titanium oxide or white pigments.

# Elimination of Tattoo Marks

Various artificial means have been devised for elimination of tattoos;

a) **Dermabrasion**
b) **Application of caustic substances**(corrosives)
c) **Application of carbon dioxide snow**
d) **Electrolysis**(releases and dissolves pigments to be washed out)
e) **Surgery**(skin grafting)
f) **Cryosurgery**;and
g) **Exposure to laser beams**(destroys pigmented cells and evaporates the dye from tattooed area without pain,damage,or alteration of skin structure

# Describing a Tattoo

While describing a tattoo mark,special note should be made of its;

- Anatomical situation,size,color and design
- A photograph or sketch is of value.
- The possibility of the same emblem in same situation in more than one person due to the same tattooist executing the design must be kept in mind

# Confirming Tatooing in Attempted Erasure Cases

Biopsy and histological examination of draining lymph nodes can detect the presence of the pigments in them.This may help confirm erased or removed tattoo,as pigments get permanently deposited in lymph nodes draining the area tattooed,e.g,axillary lymph nodes in case of tattooing over inner aspect of forearm.

# Complications of Tattoo Marks

The important complications from tattoo marks mainly relate to;

- **Infections**

  ***pyogenic infections:** superficial -- impetigo/erythema
  deep -- erysipelas/cellulitis

  ***non-pyogenic-infections:** hepatitisB,tetanus,HIVinfections
- **Sepsis**;and
- **Transmission of diseases** like syphilis,leprosy,tuberculosis,hepatitis and AIDS
- **Acquired hypersensitivity to pigments**
- **Miscellaneous reactions**(e.g. keloids,localised sclerodermas,lymphadenitis,etc.)

# Medicolegal Importance of Tattoo Marks

- Establishment of identification of race,nationality,occupation,religion,language,name of the person or his/her beloved ones,relatives,friends,etc.
- The design could be of an idol,obscene figure,a flower,etc.representing the mental make up,desire,inclination,etc.
- As long as dermis is intact,tattoo marks can be identified in a highly decomposed dead body.
- Attempts for concealment of tattoo marks(for concealment of identity)is suggestive of positive criminal background.

- Tattooing may cause infections(AIDS),sepsis,ulcer,keloid formation,etc.
- Intravenous drug abusers may conceal injection site by a tattoo design.
- Persons involved in sexual perversions may tattoo a specific design to recognise each other.
- Unburnt gun powder/semi-burnt gunpowder particles can cause tattooing around firearm entry wound,giving a cue regarding the firearm injury and the range of firing(involuntary tattoo marks).

# Medical and Practical Application of Tattoo Marks

- Nevi flemmei(port wine stain)have been tattooed for camouflaging it.
- Vitiligo patients can be tattooed to almost normal skin color.
- Facial tattooing is the latest trend in cosmetic surgery.
- Correctional tattooing is promoted to get permanent eye lashes and eyebrows,etc.tattooed in a required style.
- Also used to create a nipple and areola after breast surgery.
- Color defects in lips after facial surgery can also be corrected.

# Scars

Scar is a product of healing of a wound by fibrosis and cicatrization.It is permanent and may grow in size with age,but its shape remains unchanged throught life if there is no keiloid formation or any other interference,rendering it an important means of establishing human identity.

# Scar and Causative Agent

- An incised wound produces a linear scar
- A gaping wound a wide scar
- A stab wound an elliptical scar
- A punctured wound a puckered scar
- A lacerated wound an irregular scar
- A bullet wound a circular,ovoid or elongated depressed scar
- Burns,scalds,and corrosives produce irregular scars with a tendency to keiloid formation(scars from scalds and corrosives often show splashing about the main injury)
- Surgical operations leave a linear scar with stitch/suture marks at regular intervals along the length of the scar.These are present at definite anatomical sites

- Linear needle track scars are seen in intravenous drug abusers and depressed scars are seen in skin poppers
- Smallpox vaccination scars,one to three in number,are circular or oval,slightly pitted,and found on outer side of arm or thigh
- Syphilitic scars are thin,tissue-paper-like,and are seen on the genitals
- Many skin diseases,like smallpox,leave characteristic scars.

with a criminal offense.

**Fig. 11.51A:** *Blunt force trauma:* Laceration wound scars on right side of the face

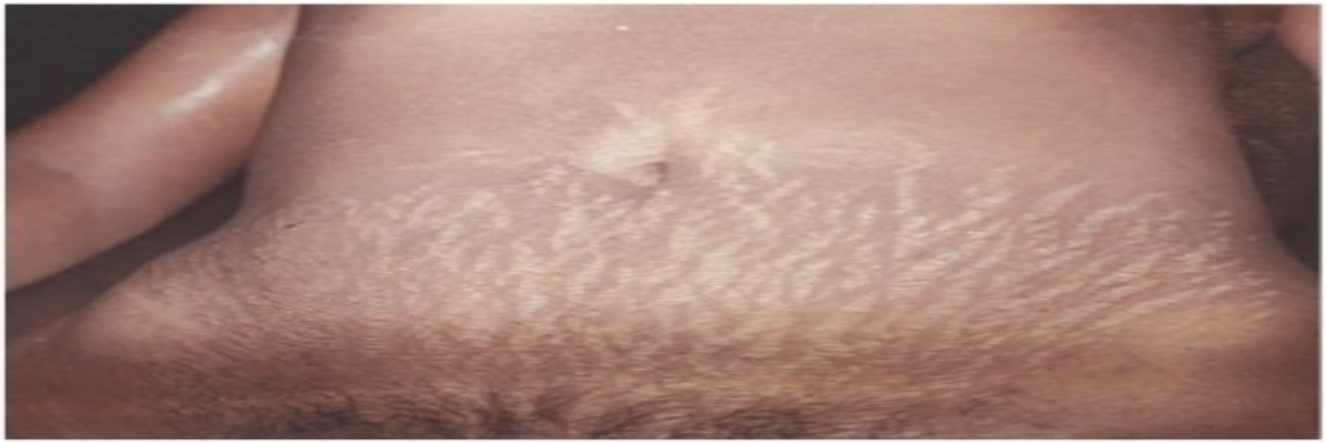


**Fig. 11.51B:** Striae albicantes—stretch marks seen in pregnancy striae gravidarum (*Courtesy*: Capt. Dr B Santhakumar, Professor and HOD Forensic Medicine, Govt. Stanley Medical College, Chennai, Tamil Nadu, India)

**Fig. 11.52:** Scar in intravenous drug addict (antecubital region)

**Fig. 11.53:** Scars of cocaine shots on dorsum of the right hand in cocaine addict

# Age of Scars

The approximate age of a scar can be estimated from its ageing process,i.e,

1) Vascular to avascular(2 weeks to 2 months)
2) Tender to non-tender(2 months to 6 months);and
3) Soft to tough(more than 6 months)

1)Depending upon vascularity,a recently formed scar may appear reddish or bluish.It is tender and soft.The age of such a scar is upto 2 weeks.
2)As the vascularity diminishes,the scar becomes pale and white but is still tender and soft.Its age is upto two months.
3)With age,the scar contracts.It becomes smaller and whiter but it is still a little tender and soft.The age is between 2 to 6 months.
4)As the scar further contracts,it becomes tough,white,and glistening.The age ranges from probably not less than 6 months to an indefinite number of years.

# Growth and Disappearance of Scars

- Scars produced in childhood grow in size with the natural development of the individual,especially if situated on the chest and limbs
- A well developed scar never disappears but scars from minor wounds may become very difficult to detect.

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# Examination of Scars

- Good lighting is essential
- The record should include the number,site,size(being accurately measured),shape,color,consistency,the level it bears to the body surface,relationship to deeper tissues whether fixed or free,tenderness if any,and the presence or absence of glistening.The condition of the ends whether tapering or otherwise and the probable direction of the original wound should also be determined.Irregular scars should be sketched or preferably photographed
- Faint scars may be made visible by exposure to ultra-violet light or massaging the area to increase the blood supply when the avascular scar stands out to the hyperaemic skin

- Suspected scars in the dead can be examined microscopically
- In fragmentary remains,a scar may be confused with lineae albicantes(striae of old pregnancy on anterior abdominal wall).A scar contains no elastic tissue.Linea albicantes formed by stretching of the skin contains elastic tissue.

# Medicolegal Significance of Scars

- Scars are helpful in identification
- Shape of scars correspond to the type of injury and thus the instrument causing it can be identified(scar due to surgical instruments and linear scar of incised wound,scar due to blunt force or unstitched lacerated wound)
- Age of scar corresponds to time of occurrence of event(crime).This is especially important in pleas of self-defence in cases of murder
- Old scars on wrist or throat indicate previous attempts at suicide
- Many scars on front of the lower legs indicate repeated falls of a chronic alcoholic
- Scars may be changed surgically into a different shape or erased by plastic surgery to avoid being charged for criminal offence

- The accused may attribute scars of wounds to disease or therapeutic procedures
- Scar may be claimed as infected wounds by accused/may be deliberately kept infected or covered with irritants to promote slow healing and obtain unsightly big scars so as to bring the injury within the purview of grievous hurt
- Scar over antecubital region or dorsum of the hand may give clue about drug addiction
- Scars may develop as a result of erasure/removal of a tattoo or as a result of destruction of fingerprints to avoid identification
- Scars are less vascular and fibrous making them resistant to putrefaction and thus rending them as an important factor in partial identification of deceased
- Scars on knees should not be considered for identification as they are most common site for injury as a result of falls during childhood in most persons

- Linea albicantes may indicate certain diseased conditions like ascites/abdominal tumor or previous pregnancy in a female.These are permanent
- Scars from rupture of the posterior commissure of vagina or tears in external os uteri are indicative of previous labour
- Linear needle track scars in intravenous drug abusers and depressed scars in a skin popper
- **Keloids and hypertrophic scars**; hypertrophic scar usually settles or begins to regress in 6 months.However,keloid may extend beyond the wound itself and continue to grow in size by 6 months.Extensor surfaces,strong and burned skin are commonest sites.Negroes and young people are affected the most.

**Fig. 11.49:** Healed scar of cholecystectomy surgery

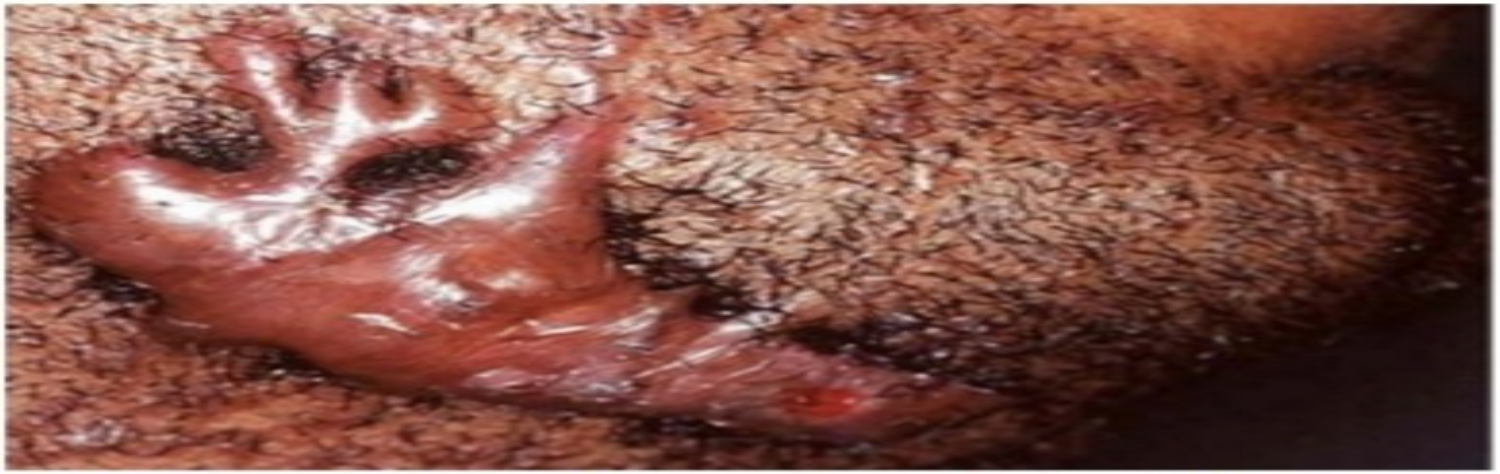

**Fig. 11.50:** Scar with keloid formation. (*Courtesy:* Dirk M Elston, MD. *Source:* http://emedicine.medscape.com/article/1057599-media)

# Obliteration of Identity

The identity of a dead person may be effaced or obliterated by the following methods;

1) Removal of identifying features,such as fingerprints,tattoo marks,scars,hair,teeth,etc,and other articles including clothing belonging to the missing person
2) Animals,eg,rats,dogs,jackals and hyenas,and birds such as vultures,which may attack the dead body.may mutilate it in a very short time when the body is lying exposed in the open
3) Burning the body
4) Advanced putrefaction
5) Dismemberment and extensive mutilation by any means including bomb explosions
6) Throwing different parts of the body in different places
7) Intermingling of parts from different bodies or animals

8) Throwing of the body into the sea,lake ,well,canal,or river
9) Dissolving the body in corrosive acid
10) Putting the dead body on the railway track so that mutilation is brought about,the body being reduced to a shapeless pulp at times.

Some of the above methods are used or resorted to by criminals to make homicide appear as suicide or accident.

# Anthropometry(Bertillon System)

This system is based on the principle that the measurements of various parts of the human body do not alter after adult age(21 years)and that no two persons show the same measurements in all respects.

The system involves registration of the characteristics under three heads;

- **Descriptive data,**such as color of hair and iris;complexion;and shape of nose,ears,chin,etc
- **Bodily marks,**such as moles,scars,tattoo marks,etc;and
- **Body measurements,**eleven in number,pertaining to certain body parts.

The photographs of the full face and right profile are also taken.

# Disadvantages of Bertillion System

- Only applicable in adults
- Errors in taking measurements by instruments
- Needs measurements of various parts of the body

**Fig. 11.55:** Sketches illustrating Bertillon's system of bodily measurements, called anthropometry, as used in United S
early 1900s. Historical aspect of anthropometry: *Alphonse Bertillon*, a French police officer and an expert introduced the system of r
the detailed physical description including exact body measurements of a subject, birthmarks, moles, colour of the iris, hairs, cor
etc. as data for establishing identity of a person. This was called *portrait parle*

# The End