

IDENTIFYING THE LIVING AND THE DEAD BY THE SKELETON

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- Often times for some reason there is need to establish the personal identity of the living person or the dead.

Identifying The Living

- The following may prevent a person from identifying themselves
 - coma
 - amnesia
 - infancy or mental defect
 - language barrier.

OTHER REASONS FOR PROPER IDENTIFICATION

- Exact age may be needed for immigration purposes or inheritance.
- **SUSPICION OF willful concealment or imitation.**

Methods of identification.

The following methods can used to identify the living

- Personal (visual) impression.
 - basis of identification parade but is notoriously unreliable
- Photography
 - more reliable in identifying the living than the dead.
- Hand writing
 - possible for experts to identify a person or detect forgeries
- Finger prints (dactylography)

Identifying the Living

- Radiographs of the hand.

Individual bones of the hands and wrists differ from person to person and can be valuable in establishing personal identity in living and dead.

- Frontal Sinuses

Like the fingerprint they also differ from person to person as well as twins and can be used to establish identity.

Evidence previous bone pathology, or fractures can be offered for comparison

AGE ASSESSMENT

- Radiograph of the skeleton can be used to ascertain the age of the living/dead person through demonstration of ossification centres.

The following bones are used:

- Bones of the hand
- Pelvis
- Clavicle
- Long bones e.g. femur, tibia, humerus and radius

- **After 25 yrs age assessment becomes difficult though in old age trabecular pattern, arthritic changes, osteoporosis and osteophytes can assist.**

Identifying the dead

- In cases of the dead, severe burns, mutilation, or decomposition cause difficult in body identification even to those who may have known the individual well.
- Forensic anthropologist or imaging specialists (FORENSIC RADIOLOGISTS) offer significant help especially where decomposition is complete and only the skeleton is available.

HISTORY OF FORENSIC RADIOLOGY

- Use of X-RAYS to produce images was discovered by W. Roentgen in 1895 accidentally
- Weeks later forensic use of X-rays was tested and helped convict a murderer in the USA

Definition of Forensic Radiology

- It is a specialized area of medical imaging using radiological techniques to assist physicians and pathologists in matters related to the law.
- Radiographs must be taken **before dissection**.



Earliest photograph of roentgenography
of a cadaver found by the author.

<http://www2.le.ac.uk/departments/emfpu/imaging/brief-history>

What are the uses of forensic radiology?

- 1. Suspicious death or murder** - prior to autopsy, radiographic techniques can assist the pathologist in determining the potential cause of death and may alert them to a previously unsuspected suspicious death. Autopsy technique may need alteration given the prior knowledge of specific radiographic findings.
- 2. Analysis of adverse medical events** - during the course of hospital admission or medical care, adverse events may occur. Radiographic imaging is an integral part of the medical process and provides a permanent record of the patient's condition. Specialist review of these images in the light of autopsy findings and clinical audit can aid in the prevention of future mishap.

3. Legal matters - following injury or assault radiological imaging is commonly obtained by medical practitioners. Expert interpretation of these images may provide useful evidence in criminal and civil jurisdictions

4. Child abuse - as part of the workup of children with suspected abuse, radiological techniques are mandatory in providing evidence of both acute and chronic injury. Some of the findings are very specific for abuse and crucial for conviction of culprits


5. Drug trafficking - increasingly sophisticated methods are used by drug traffickers to avoid detection. This includes the deliberate ingestion or cavity insertion of drugs wrapped in protective materials (known as body packing). These packets are readily identified on radiographs and CT scans and can assist law enforcement agencies in screening suspected individuals

6. Body identification - along with dental and DNA analysis, radiographic images can be used in the identification of unknown victims. This requires the securing of pre-mortem examinations e.g. CT scan or radiographs from a suspected individual and the matching of specific anatomical details with similar post mortem studies

7. Disease identification (e.g. Marfan's) -

during the course of an autopsy there may be findings that can have consequence to the deceased family i.e. the detection of possible genetic disease. In order to confirm such a pathological suspicion, radiographic procedures can provide confirmatory evidence and as such lead to the deceased's family being offered genetic screening

8. Donor bank analysis - all body parts donated for use as grafts in particular bone must be carefully screened prior to use in order to avoid the insertion of "diseased" material



Modalities

- General X-ray
- Fluoroscopy
- NM
- CT
- MRI
- Dental Identification
- Angiography and venography
- US

Role of forensic Radiology

- Forensic radiology has been used to provide evidence to help confirm the identity of both living and the dead thru evaluation of;
 - Age
 - Gender
 - Race

Comparison of antermortem and postmortem radiographs is one of the most accurate means of identification of the decomposed bodies

A. Identification

- Age

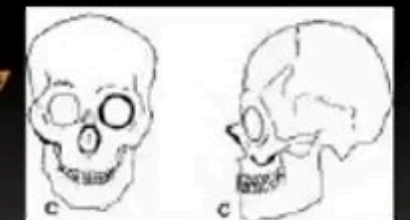
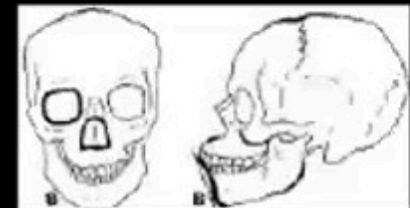
- **Child:** by the appearance of centers of ossification for hand and wrist.
- **Young adult:** by the state of fusion of epiphyses.

- Race

Images basically for skull.

Skeletal racial Groups:

- a) Negroid – elongated cranium
- b) Mongoloid – **rounded** cranium
- a) Caucasoid- Head is curved at the top, not completely flat, The chin is prominent.



A. Identification

- Gender
 - Usually the 1st step in ID process.
 - The sexual characteristics recognizable by radiography begin to appear after puberty.
 - RT takes Images for the skull, long bones and pelvis.

SKULL

F, more vertical forehead
M, less rounded forehead

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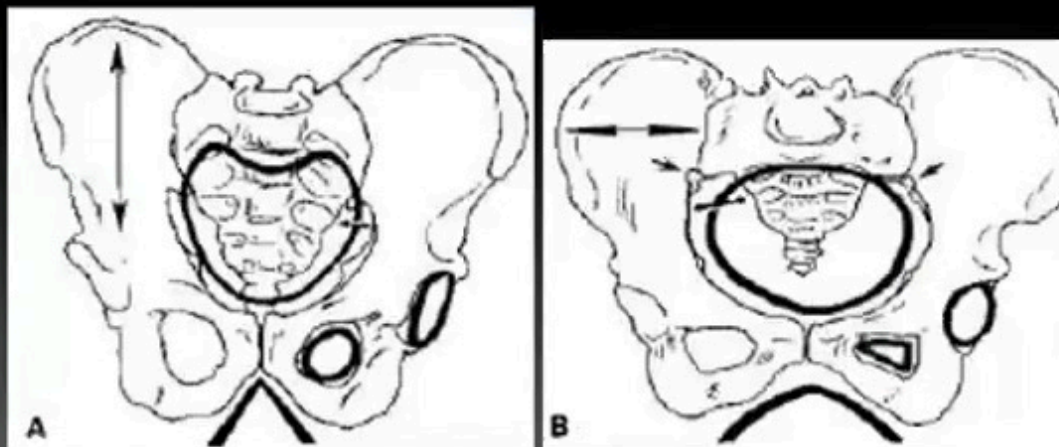
PELVIS

F, larger & more round

M, more oval

A. Identification

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 - RT takes Images for the skull, long bones and pelvis.



A: male pelvis. B: female pelvis

B. IDENTIFICATION

II. Comparative Identification:

Depends on comparing antemortem to postmortem X-Rays of a person. Comparison includes:

- Normal structures: comparison of skull sinuses especially frontal sinuses regarding the size and shape.
- Abnormal structures: congenital anomalies of bones, deformities and/or fractures.
- Dental radiographs: comparing root shapes, teeth fillings and abnormal teeth eruptions.

B. Cause of death

1. Foreign bodies location
2. Demonstration of tracks
3. Demonstration of injuries or disease
4. Child abuse

Foreign bodies

- packages of illegal substances
- objects such as bullets, fragments of glass, explosives or pieces of broken needles in drug addicts in the soft tissues.
- The location of swallowed objects can assist in correlating time of death with possible cause of injury.

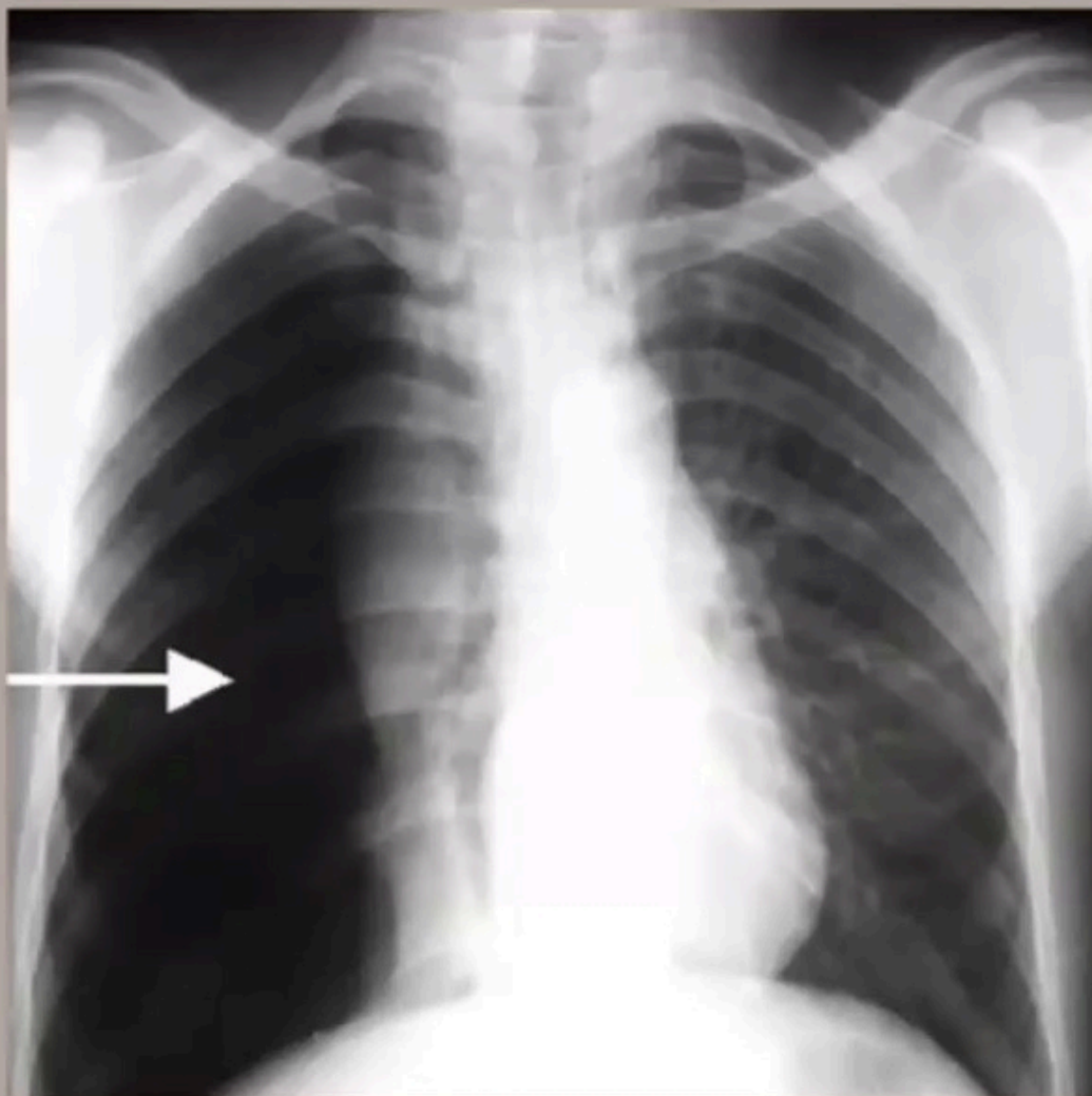


foreign body (button battery) in the proximal esophagus

A. RADIOLOGY OF INJURY

I. Soft tissue injury:

3-Abnormal collection of air in the chest → pneumothorax: Right-sided pneumothorax (arrow) on plain CXR



A. RADIOLOGY OF INJURY

II. Fractures:

1. Hidden fractures:

An infant who was hit in the back of the head with a blunt weapon, and sustained a separation of the odontoid process from the body of C2 with anterior subluxation of C1. Note separation of the spinous processes at the level of injury.



General X-ray:

Shard of glass (arrows) from a broken beer bottle remain in the lung of this stabbing victim.



Fluoroscopy:

Post-operative chest x-ray and intra-bronchial contrast material with initial tracheal stent in place.



NM:

This is a nuclear scan for died person that dead in isotope environment. It is show some of the isotope is taken up by the kidneys and excreted into the bladder which should have been emptied before the scan was done.



CT:

Recently, more popular

Why?

- ↓ Time , ↓ cost
- Improved scan quality
- Some says that CT will replace other modalities in forensic radiology.

C. DETECTION OF SMUGGLING

I. Addictive agents (body packer):

Abdominal radiograph of a body packer showing rounded and ovoid, slightly hyperdense packages, some of which are clearly surrounded by a halo of entrapped gas or air (some are marked with arrows).



C. DETECTION OF SMUGGLING

I. Addictive agents (body packer):

CT images of a body packer shows multiple drug packages somewhat denser than the bowel, most of which contain entrapped air at the ends of the packages.



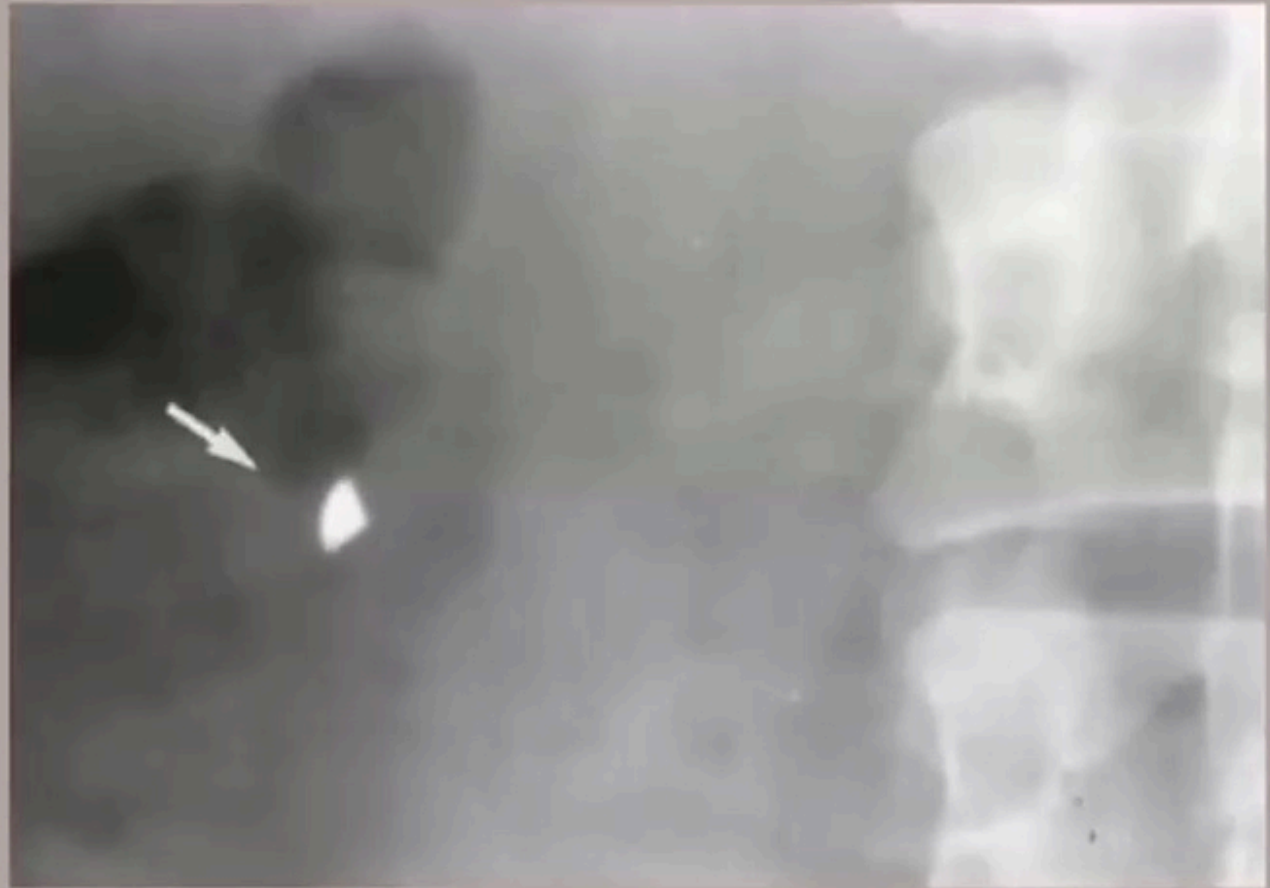


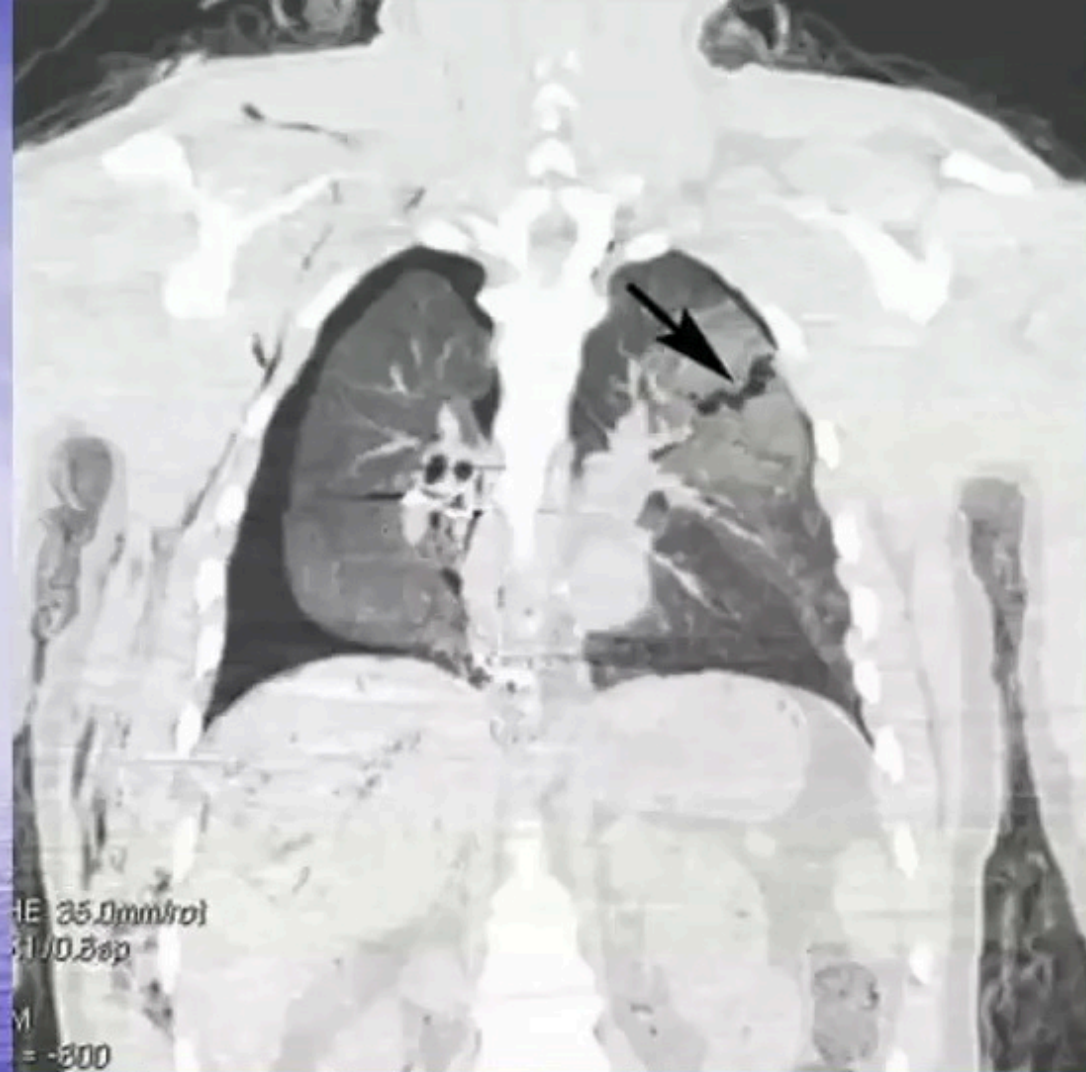
Frontal radiograph of the chest from a victim of a gunshot wound to the chest. This image shows metallic bullet fragments overlying the heart and right lower chest. There are right posterior rib fractures and a bilateral pneumothoraces.

C. DETECTION OF SMUGGLING

II. Jewels (larceny by ingestion):

Radiograph of the abdomen of a suspected jewel thief. Note the dense object (arrow) in the shape of a brilliant cut diamond.





Coronal multidetector computed tomography (MDCT) scan of the chest from a victim of a gunshot wound to the chest. This image shows a gas-filled gunshot wound track that extends from the left upper lobe (arrow) to the right lower lobe. Metallic bullet fragments are located in the right lower lung and adjacent to the right hemidiaphragm.



Coronal multidetector computed tomography (MDCT) scan from an aviation accident victim who died from blunt trauma before the fire of the crash

SEXING

- The skull, pelvis and muscular attachments can be used to differentiate between sexes in adults.
- Femur and sternum can assist.
- The pelvis is the most helpful bone

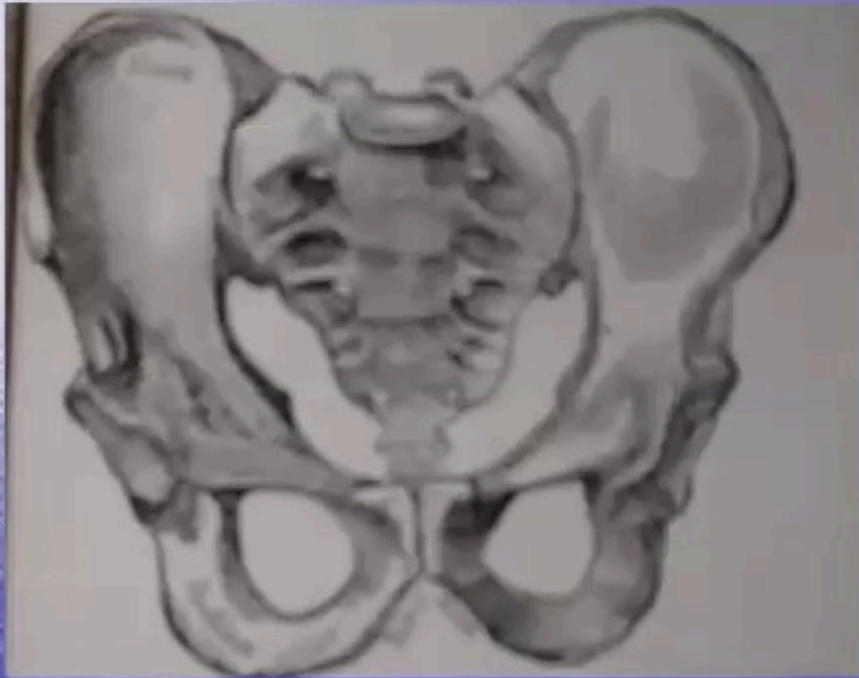
The differences are usually seen after puberty hence not possible in children

Sex determination from pelvis

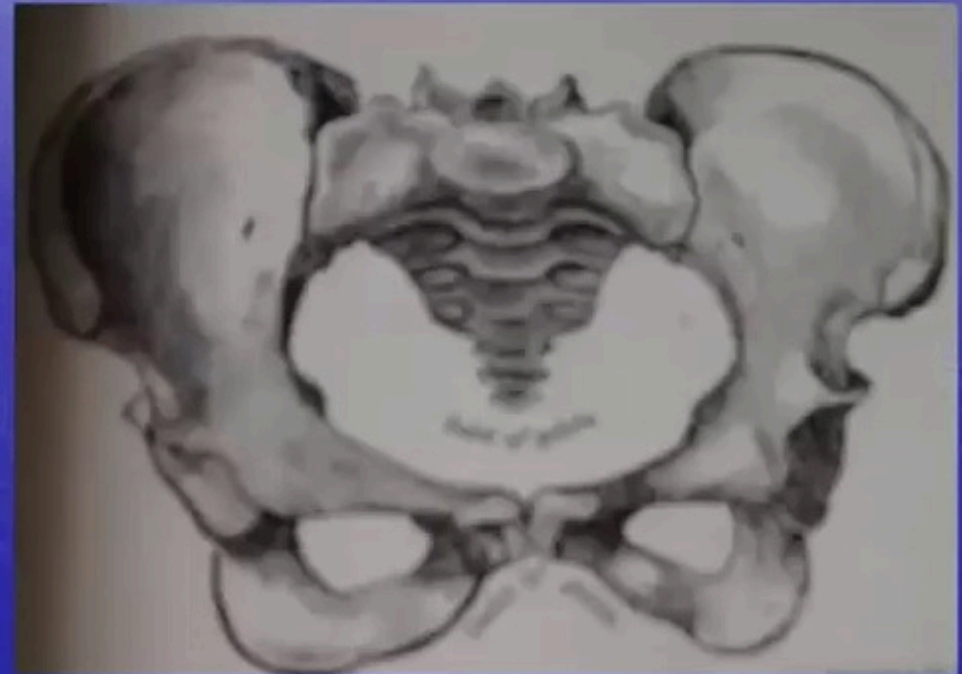
Pelvic bone	Male	Female
Brim	Heart shaped	Circular or elliptical
Body of pubis	Triangular	Quadrangular
Sub pubic arch	Inverted V shaped	Inverted U shaped
Greater sciatic notch	Deep and narrow	Broad and shallow
Sacro iliac joint	Large	Small
Sacrum	Long and narrow	Short and wide

- Objective sex determination from pelvis is based on anatomical pelvic measurements

Male pelvis



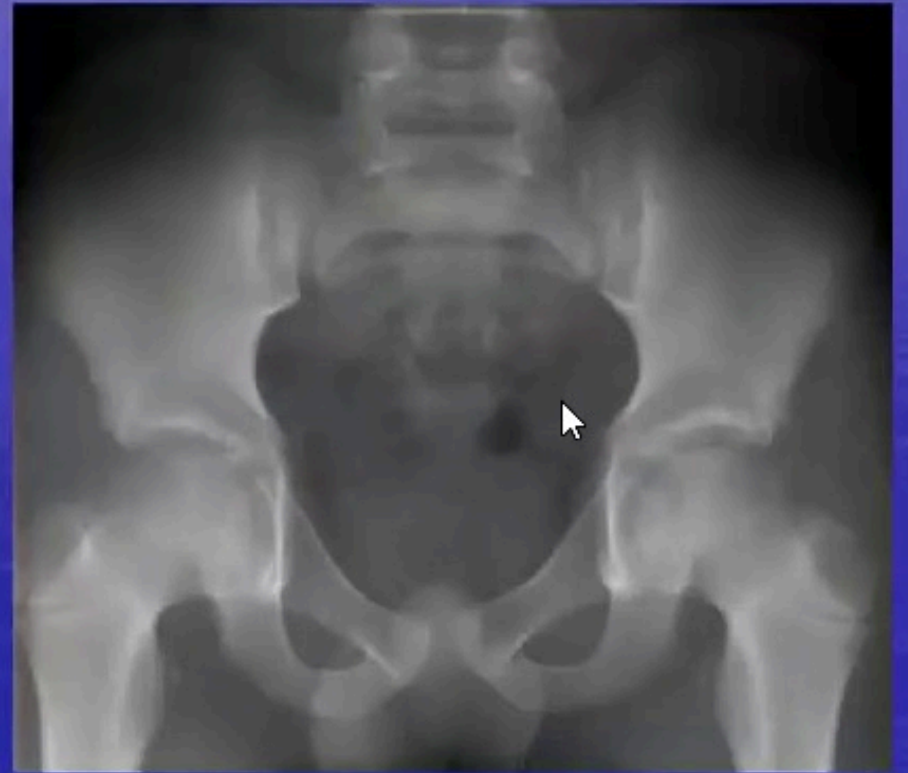
Female pelvis



Female pelvis



Male pelvis



Identification of the sex using the above bones:

- gives up to 50% accuracy
- Is not reliable
- Is not useful in children below puberty
- a large sacroiliac joint suggests female
- The greater sciatic notch is deep and narrow in the female

Sex determination from the skull

The following structures can be used to determine sex from the skull.

- Supra orbital ridges
- Mastoid process
- Palate
- Orbit
- Mandible

Experienced persons can correctly sex over 90% caucasian skeletons and 83% American negro skeletons.

Need to identify the dead

- There is no greater challenge and no heavier responsibility than that facing professionals charged with identifying the dead.
- Something deep in the human psyche abhors loss of identity even of the deceased.
- Reverence paid to tombs of unknown soldiers the world over attest to the pathos and disquiet we feel about those who have lost **their identity in death.**

- Every unidentified body represents a person missing to family and friends.
- Without identification the family continues bearing the burden of continuing the search for the missing person.
- Religious ceremonies and culture bear witness to the need for the living to put the dead to rest.
- Without proper identification this is impossible.

- As corollary of these intense emotional issues few activities satisfy medico-legal professions as making proper identification of a body originally found unidentified.

Importance of identifying the dead

- Death certificate

Without which families cannot probate wills, receive death benefits or enter safety deposit boxes.

- Spouses cannot remarry
- If homicide detective has no lead.
- Cases of unidentified bodies, investigator may not have adequate cause of death.

Methods

- Medico-legal professions will dictate the methods used.
- Two main methods:-
 1. Least reliable and least reproducible involves visual review of the remains, photographs and details such as tattoos, personal effects on or about the body
 2. Most reliable involves documentation on or in the body of criteria and characteristics e.g. fingerprints, dental records, healed fractures, surgical sutures, previous photographs, radiographs,

Important factors that aid in identification

- i. condition of body
- ii. age
- iii. history of victim,
- iv. resources from authority
- v. set parameters on which one can make positive reproducible identification of the dead.

- Two main generalities apply that all techniques from visual observation to DNA profiling rely on pattern recognition.
- The more intact the pattern the easier it is to identify

Complex Cases

Variety of professionals required, including:

- i. Finger print expert
- ii. Anthropologist
- iii. Radiologists

The team can be large however the medical officer certifying the death has ultimate responsibility for assuming identity of the body and should be the team leader.

- Greatly decomposed body or severe mutilation by fire, make it difficult for visual identification.
- Scientific methods have to be employed.
 - Collect dental data
 - Medical records
 - Ante-mortem radiographs
 - Finger prints

- Radiological determination of individual's identity may be presumptive upon demonstration of the pre-existing injuries, illness or congenital and developmental peculiarities.
- Positive radiological identification requires direct comparison with ante-mortem and post-mortem images of body parts.

- Imaging will help confirm that the bones are human and that what is presented is really bone.
- When most of the skeleton is present, imaging can differentiate between sexes
- Imaging can ascertain the age
- Imaging show evidence of foreign bodies and presence of bone disease.

PERSONAL IDENTITY

- Placing a name requires having reliable ante-mortem
 - Dental records
 - Medical evidence of injury
 - Presence of foreign bodies
 - Old fractures

Contd...

- If skull radiograph is present comparison of frontal sinuses will be of great help.
- Lateral skull films can help
- Other bones that can assist include:
 - Upper ribs
 - Humerus
 - Femur
- Facial reconstruction can be done using skull radiographs

- newer cross-sectional imaging modalities which display body parts in section and planer images quite differ from the frontal and lateral views commonly used.

- Radiographs of variety of anatomic parts mainly skull, extremities and abdomen usually required.
- Dental records and radiographs are most productive tools

Determining the ancestry (race)

- The skull is the best source of information for estimating ancestry morphology and metric analysis of skull, can show the geographic population to which the individual belonged.
- Geographic population is a large collection of people e.g. Europeans, Africa and Asians and is usually referred to as race.
- Skull only indicates genetic ancestry not solid connotations.

Cranial characteristics and their expression in specific population groups.

Skull	African	Asian	European
Skull length	Long	Long	Long/short
Skull breadth	Narrow	Broad	Narrow
Nasal aperture	Wide	Narrow	Narrow
Incisor shape	Spatular	Shoveled	Spatular

Stature estimation

- Height estimation is a metric procedure.
- Predictive equations have been developed that estimate stature based on length of various bones of the body.
- The equations exist for several populations
Trotter and Gleser designed the most commonly used equations in response to repatriation of world war II victims.
- Leg length is greatest contributor to height.
- However when people enter 30 years they begin to lose height
correction of 0.06cm per decade required.

Trauma analysis

- Difference between premortem and postmortem damage.
 - blunt force –fracture or crushed bone
 - sharp force –nicks grooves direct weapon
 - gunshots – beveled shapes trace of lead burning
- Post mortem does not have plastic behaviour of antimortem bone.

Idiosyncratic characteristics

Individual characteristics can be the clearance indicators of identity.

- Features in medical records or characteristic in family
- Comparing for antemortem and postmortem radiographs.
- Superimposition of photographs taken in life marked to skull features.
- Facial reconstruction based on sex, ancestry, age

- It is obvious the skeleton is not only a framework from which we work muscles, but also forms our identity.

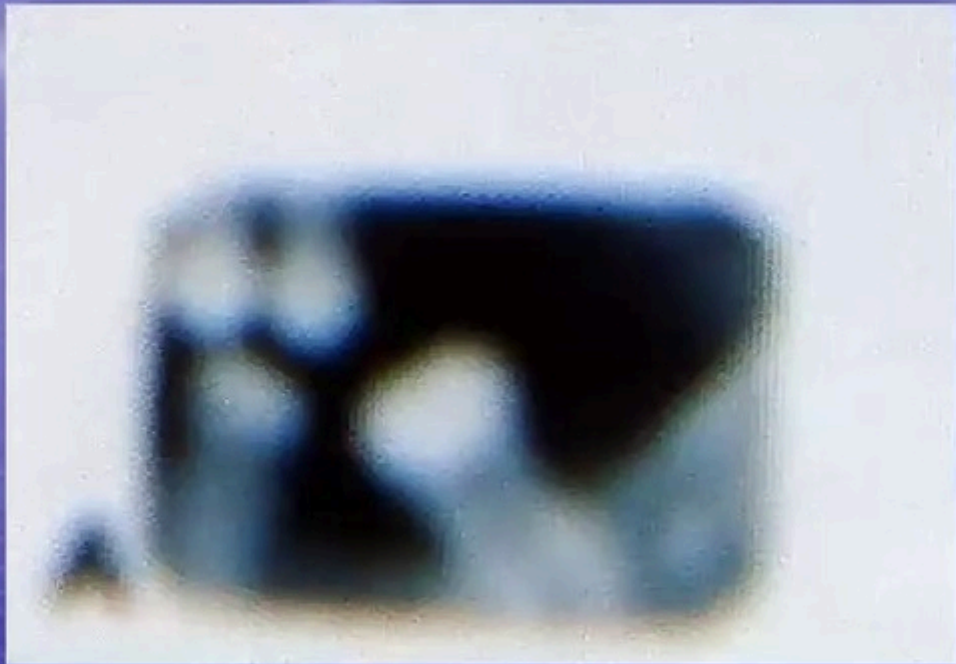
- Age
- Sex
- Ancestry
- Unique characteristics
- Trauma/disease

The skeleton is very helpful in adult identification.

- What can we say?

Dead men do tell tales.

Information from the skeleton provide information for reconstruction of communities and historical events.





- In decomposed bodies radiographs of the skeleton and the dental records form the main method of identification.
- Radiographs can help identify race, sex and age at time of death.
- Radiographs are also helpful in cases of co-mingled and differentiation between human and animal bones.

- Radiological identification has been helpful especially in disasters e.g. in 1949 fire aboard the Great Lakes radiographs helped identify 75 cases accurately.