Chapter 11 – Death, Trauma & the Skeleton

- Trauma
  - Injury cause to living tissue by an outside force
  - Caused by any hard surface, chemicals, heat, cold
- Role of anthropologists
  - Decide if trauma occurred at the time of death→may provide evidence
  - Force that caused the trauma eg. weapon characteristics
  - # of wounds→determines manner of death
  - Sequence of wounds→information about the circumstances of death
  - Placements of wound→determines manner of death & location of attacker
- Trauma interpretations
  - Wounds on top = tall person
  - Crush trauma caused by a club = male
    - Females aren't strong enough
  - Font trauma to the left side of the body = right-handed
- Procedures
  - Determine cause & manner of death
  - Determine forces causing trauma
  - Describe types of trauma: projectile, blunt, sharp & miscellaneous
  - Timing of bone injury

<u>Cause & manner of death</u>

- Cause of death
  - Person stops breathing & heart stops beating
  - Disease
  - Almost impossible to determine cause just by examining bones
    - Don't use "cause" BUT "consistent"
- Bone trauma is usually the only source of info about cause of death available from skeletal remains
- Manner of death
  - The way a person died
  - Homicide
  - Suicide
  - Accident
  - Natural
  - Unknown
- Bone usually only exhibits clues concerning violent deaths (homicide, suicide, accident)
- Disease (natural) may leave bone markers

Not anthro's job

<u>Fracture</u>

- Break
  - Discontinuity
- Fracture
  - Break travels completely through the bone
- Displacement
  - Surfaces that once were continuous no longer meet OR meet at an unnatural angle
- Complete fractures
  - Bones separate from each other
- Simple fracture
  - Single discontinuity results in a bone broken into 2 segments
- Comminuted fracture
  - Breaks that result in the production of multiple fragments of bone
  - Common in deaths caused by violence

- Infraction
    - Break doesn't travel completely through the bone
- Hinge fracture
    - Part of the fractured area is still attached to its original bone
    - Surfaces meet at an unnatural angle
- Green stick fractures
    - Breaks in bones where separation between broken ends don't occur

- Pathological fractures
    - Breaks that occur in bones because weakened by disease
- Stress fractures
    - Breaks caused from overuse
- Fatigue fractures
    - Bones that are exposed to intermittent stress over a long period of time
- Dowager's hump
    - Spinal column is angled so prominently forward as to appear to form a hump on the back
    - Most common in persons suffering from osteoporosis (bones become brittle & fragile)
        - Also a pathological fracture

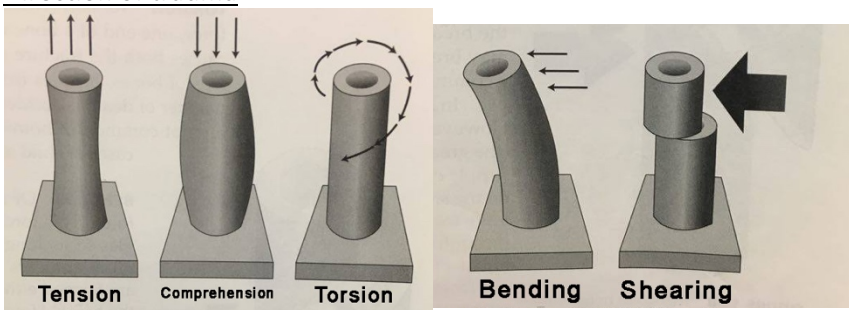
<u>Fracture lines</u>

- Fracture lines
    - Originate near the point of impact and dissipate the force across the bone surface
    - Generally won't cross preexisting fracture lines/suture lines
        - Hit preexisting discontinuity→energy lost
    - Usually radiate from & around the point of impact BUT can appear at the opposite side of the structure receiving the force
- Radiating lines
    - Disperse outward, irregular sunburst, from the area of applied force
    - Most common
- Hoop (concentric) fractures
    - Caused by the inward & outward bending of the surface of the bone

<u>Responds of injured bones</u>

- Hematoma
    - Veins & arteries are ruptured by the break→leak blood→**pool** over damaged area
    - Helps stabilize the broken pieces
- Osteogeneic layer produce connective fibers that span between the broken surfaces
    - Flexible tissue→can infiltrate the hematoma to bridge the gap
    - Fibers form the framework for the development of callus
- Callus
    - Composed of fibrous bone
    - Doesn't have the strength of ordinary bone because it's not well organized & matrix isn't dense
    - Begin to from by the 6^{th} week after injury
    - Are visible & raised
    - In some cases, with enough time, all traces of fracture & callus can be resorbed→no indication of previous break
        - Sharp borders of break become round
        - Pores develop in the area of the break
- Replacement of fibrous bone with lamellar bone
    - Much stronger because greater organization & dense structure

Direction of trauma



- Tension
  - Force that pulls on bone, usually along its long axis, with sufficient energy to cause a break
  - Common in dislocations
  - Exhibit few fracture lines
  - Common in accidents
- Comprehension
  - Push down on bone
  - Can be complete or incomplete
  - Usually radiating fracture lines
    - Can be numerous & wide reaching
  - Commonly found in skull
  - Mirrors weapon
- Torsion
  - Common in accidents
  - One end of bone is held stationary while the other end is twisted
  - Fracture surfaces and the lines spiral down the long axis of bone
- Bending
  - Most common
  - Impacts the side of a structure ~right angles to its long axis→break through its cross section
  - Few fracture lines
  - If force is great→triangle of bone may break→comminuted fracture
  - Parry fracture of the ulna is very common
    - Hold arms up, bent at the elbow as self defense
  - Children – infraction
- Shearing
  - Similar to bending but involving immobilization of 1 segment of the bone
  - Fall forward when victims catch themselves
    - Ground immobilize bone and weight of the body delivers side force
  - More common with accidents

Speed of force

- Dynamic
  - Sudden stress that's delivered powerfully & at high speed *eg. car accident*
  - Causes most of the discontinuities & fracture lines in violent deaths
  - Delivered by a bludgeon, knife or dynamic projectile
- Static
  - Stress that's applied slowly
  - Starts low & builds up to the point where the bone breaks
  - Breaking of the hyoid bone during *manual strangulation*

Focus of force

- Narrow
  - Applied to a single point / thin line *eg. stab by knife*
  - Pointed/sharp-edged instrument
- Wide
  - Delivered over a large area of bone *eg. fall from cliff*
  - Breaks over a considerable % of bone area

Types of trauma

- Blunt force trauma
  - Resulting from a blow from wide instruments that have flat/round surface
  - Result of compression, bending & occasionally shearing
  - Cause at least simple fracture, comminuted fractures
  - Caused by any hard surface
- Sharp force trauma
  - Caused by instrument with a point/edge
  - Results from compression/shearing over a narrow focus
  - Force applied perpendicularly & down onto the surface→puncture/chop marks
  - Chopping instruments→complete discontinuities
  - Cutting instruments→infractions
- Projectile trauma
  - With characteristics of blunt & sharp trauma
  - Force usually compressive, sometimes bending
  - Speed is dynamic
  - Focus starts out small and becomes wide as the projectile passes through the bone
- Miscellaneous trauma
  - Caused by static pressure (strangulation)
  - Generalized dynamic pressure (explosions)
  - Sawing
  - Chemicals
  - Heat
    - Static & can exhibit both discontinuities & fracture lines

Complete discontinuities & displacement

Timing of bone injury

- Antemortem
  - Trauma before death
  - Clues for positive identification
  - Round edges of wound
  - Pores near break
  - Fracture lines appear as V-shaped grooves or disappear
  - Presence of callus
    - Irregular shape, raised, disorganized surface
- Perimortem
  - Trauma around the time of death
  - No signs of healing
    - Sharp edges
  - Green bone response
    - Bone is still hydrated→bone more likely to bend than fracture/break
  - Hinging
    - When section of bone is bent away from direction of a blow
    - Usually inward bending, dry bones will snap off
  - Usually irregular radiating fracture lines

    - Shape of broken ends
        - Angled with a jagged surface
        - Don't have flat bone surface
- Postmortem
    - Trauma after death, when bone is dry
    - Rarely have radiating fracture lines (fracture lines only occur when alive)
    - Bone is dry→likely to snap
    - Green stick fractures & hinging are rare
    - Long bones usually break nearly at right angles, with ends almost flat
    - Broken surface will be lighter (less time exposed)

Chapter 12 – Projectile trauma

Types of firearms

- Handgun
- Rifle } shoot single projectiles
- Shotgun – shoot multiple projectiles

Bullet size

- Caliber: Diameter of a projectile and/or barrel of a handgun/rifle
- Gauge: maximum weight of a lead ball that would fit down the barrel of the weapon
- Pallets: solid balls made out of lead /steel
    - Denoted by birdshot/buckshot number

Bullet construction

- Projectile shape, internal composition & covering (jacketing)
- Profile/shape
    - Sharp – rifle
        - Go clean through
    - Blunt – handgun
        - Most likely to deform on impact→cause larger (especially exit) wounds
    - Hollow-point – handgun
        - Most likely to deform on impact→cause larger (especially exit) wounds
        - Designed to expand when hitting & traveling through target
- Internal composition
    - Solid lead
        - Heavy & deforms more
- Jacket
    - Full-metal jacket
    - Semijacket
    - Nonjacketed
        - Most likely to deform because they lack the reinforcing afforded by a covering

Projectile velocity

- Speed
- Power of a projectile is related to its weight
- Double the weight=doubles its energy
- Double the velocity=quadruples the energy
- Rifles produce higher velocity bullets
- Magnum handgun have similar velocity as rifles

Bullet travel

- Move toward target while spinning around its long axis
- Rifling (spiral grooves) in the internal surface of barrels cut the bullets
    - Give it spin so that the bullet will go straighter for a longer period of time
- At the beginning the bullet is parallel to its flight path→start to tumble
    - Hit target before tumbling→head on→circular shape
    - Hit target after tumbling→noncircular wound
- Shoot at 90°→circular outline
- Not shoot at 90°→noncircular wound
- Penetrating (entry) wound
- Exit wound
    - Occur only if it has enough energy
    - Larger than entry wound

- If bullet enters intact, its characteristics will be seen in target

Effects of bullets on bone
- Wound is formed in/through the bone
- Fracture lines radiate out/encircle the point of impact
- Bone can fracture

Wound beveling
- Entry wound smaller than exit wound→funnel shape (beveling)
- Inward beveling
    - In entry wound
    - Outer hole is smaller than inner hole
- Outward beveling
    - In exit wound
    - Inner hole is smaller than outer hole

Wound shape
- Round
    - 90°
    - More likely in entry wounds
    - More likely to be caused by jacketed projectiles
    - High velocity
- Oval
    - < 90°
    - When bullet is tumbling
    - More likely in entry wounds
    - More likely to be caused by jacketed projectiles
- Keyhole
    - Caused by bullets that graze bone with little penetration
        - Angle of tractor is acute in the extreme
    - Can be seen in entry & exit wounds
        - Fairly round entrance with inward beveling connected with a splayed out triangular exit wound with outward beveling
    - Most often in cranial vaults
- Irregular
    - Caused by shattering, gives the appearance of a bone that has exploded
    - More likely in exit wounds
    - Usually caused by blunt and hollow-point bullets
    - Nonjacketed bullets

Wound size
- Wound type and bullet characteristics affect wound size
- Larger wounds
    - Exit wounds
    - Larger-caliber ammunition
    - Unjacketed
    - Hollow-point
- Larger-than-caliber entry wounds
    - Thicker bones cause bullets to deform more (larger wound)
- Smaller-than-caliber entry wounds
    - Young individuals with pliable bones
    - Passage of a bullet through a suture/preexisting fracture line

Fracture lines

- More powerful weapons→more extensive fracture lines
- Sometimes follow suture lines
- Radiating
    - Originate from the site of impact and move outward
    - Follow areas of weakness
    - Stop when they encounter fracture/suture line
- Concentric
    - Encircle the point of bullet impact
    - Caused by powerful weapons
    - Caused by intracranial pressure created by the bullet as it passes through the skull & compresses soft tissue in front of it
    - Outward bevel
- Butterfly
    - On lone bones
    - Around the site of bullet impact on the diaphysis
    - Diamond-shaped lines extending along the long axis of the bone
    - Extend up & down from bullet impact
- Irregular
    - On long bones
    - Shattering of the bone outward
    - Gunshot wound to the ribs

Bullet wound analysis

- Description of wound
    - Placement, size, shape, fracture lines
- Estimation of caliber
    - Only necessary when the bullet can't be found
    - Best to only use round/oval holes that aren't located in sutures/fracture lines
- Estimation of bullet construction
- Estimation of bullet velocity
    - Low velocity
        - Regular handguns
    - High velocity
        - Rifles & handguns using magnum ammunition
        - More likely to cause exit wounds
        - More likely to cause radiating & concentric fractures
        - More likely to shatter the skull
    - Large fractures radiating from entrance wound + concentric fracturing = rifle or magnum gun
- Estimation of direction of fire
    - Round-shaped wounds = bullet axis was at a near 90° to the bone surface
    - Alignment of entry & exit wounds
    - Keyhole wound
        - Round part of the defect that exhibits inward beveling points to the placement of the weapon
    - Usually don't go all the way through especially for thick bones
- Estimation of sequence
    - Locate defects & distinguish entrance & exit wounds
    - Distinguish fracture lines
    - Follow the fracture lines from their origin to their terminus
        - If terminus is at another fracture line→it is later in sequence
    - First wound = radiating fractures don't end at another line
- Miscellaneous estimations

Pallet wound analysis

- Direction of fire
  - Placement of pallet wounds
- Range of fire
  - Further distance between target & weapon→disperse pattern

Chapter 13 – Blunt trauma

Size

- Length & width
  - Weapons with small width need less force to cause fractures
    - Weak person can cause large fractures
- Long VS short
- Narrow VS wide
- Focused VS diffuse
  - Focus = area of impact is visible

Shape

- Cross-sectional outline & longitudinal configuration
  - Round
  - Angular
    - More common in bludgeons (stick with a heavy end)
    - More likely to cause a distinct, incisive edges with fewer fracture lines
    - More likely to leave imprint of shape
- Longitudinal configuration
  - Straight long axis *eg. baseball bat*
  - Curve, angle, bend *eg. crow bar*
    - Can only be detected under optimal circumstances
- Patterned injuries
  - Most easily seen on soft tissue
  - Rare on bone
  - Most prone is cranial vault because bony, unprotected by muscle & soft tissue

Weight

- Light
  - Fewer fracture lines
  - Smaller wound
- Heavy
  - Extensive fracture lines
  - Bigger wounds
  - Cracking
  - Fragmentation
- Not applicable to some blunt force injuries
  - Collisions with moving vehicle
  - Falls from high places
- Diffuse fracturing→less accurate estimate of weight

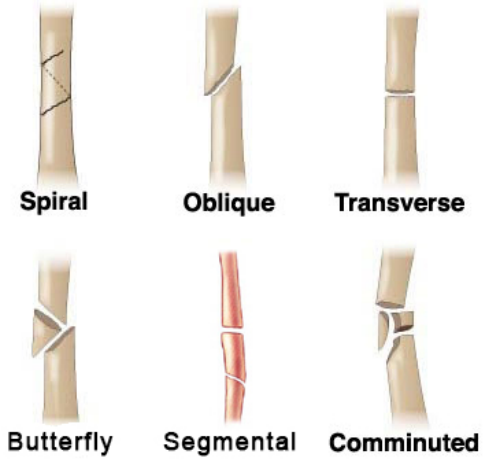
Incomplete fractures

- Bow fracture/plastic deformation
  - Caused by compression along the long axis
  - Cause bone to bend to an unnatural degree
  - Miniature fractures running obliquely across the long axis
- Bone bruise/occult intraosseous fracture
  - Microfractures to trabecular bones (ends of long bones) due to compression
- Torus/buckling fracture
  - Compressive forces cause outward buckling of the cortex around the circumference of the bone
  - Between metaphysis & epiphysis

- Greenstick fracture
  - Transverse fracture
  - Diaphysis bent at abnormal angle
- Toddler's fracture
  - Oblique/spiral fracture
  - Ends don't separate
  - Most often in lower limbs of infants & toddlers
- Vertical fracture
  - Compressive forces split the bone along its long axis
- Depressed fracture
  - Compressive forces
  - Most often in skull and long bones

<u>Complete fractures</u>

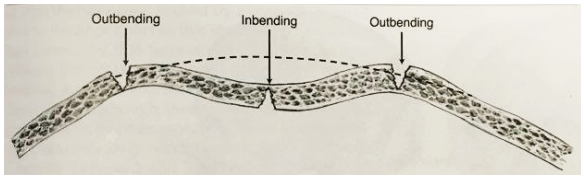
- Transverse fracture
  - Due to bending/shearing forces
  - 90° break in diaphysis
- Oblique fracture
  - Due to bending & compression forces
  - Pass through shaft at 45°
- Spiral fracture
  - Due to torsion
  - Obl ique-like
- Comminuted fracture
  - 2+ fragments
  - Butterfly fracture
    - Due to compression & bending
    - A wedge of bone separates from the 2 other pieces
  - Segmental fracture
    - 3 segments: medial & lateral piece separated by a section
    - 2 separate forces applied to bone simultaneously
    - When bone impacts a large surface
- Epiphyseal fracture
  - Ends of long bones
  - Separate epiphyses & metaphyses & divide either of these 2 structures into 2 or more pieces

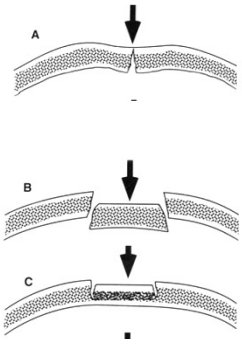



Epiphyseal

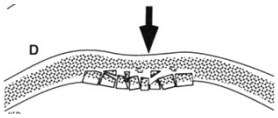
<u>Fractures on skull</u>

- Inbending
  - Impact site
  - Concentric (hoop) fracture lines
- Outbending
  - With radiating fracture lines
- Elastic bones
  - Deform inwardly at the point of impact
  - Outer table under compression & the inner table is under tension
    - Bones fail easier under tension→fracture lines on the inner surface & progress outwards
- Brittle bones (older people)
  - Strong force
    - Drive through both tables→plug of bone pushed into cranial vault
  - Weak trabecular bone
    - Diploe crushes under the force→depressed fracture



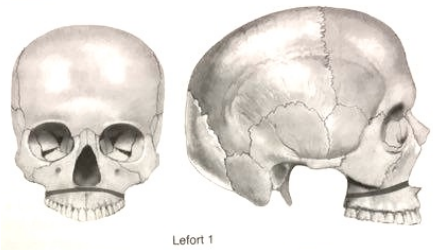


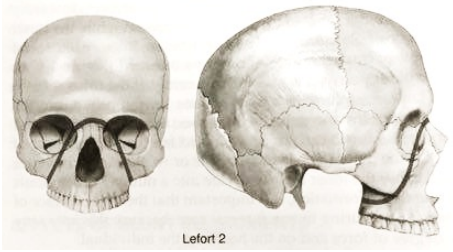
- Inner table is weaker than outer table
  - Inner table will divide into a number of segments

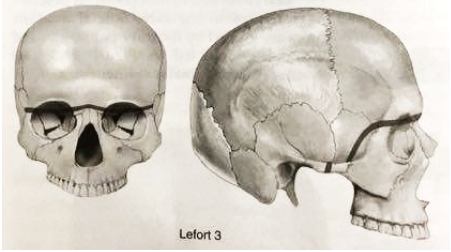


Effects on face

- Blunt forces are guided by
  - Aveolar ridge
  - Malar eminences
  - Nasorontal process
- Results in LeFort fractures







LeFort 1	LeFort 2	Lefort 3
• blows from lower face	blows in the middle of the face	separate face from brain case

Effects on cranial vault

- Blunt forces are guided by
  - Midfrontal
  - Midoccipital
  - Posterior temporal
  - Anterior temporal
- Ring fracture
  - On the base of the skull
  - Caused by skull being forced down onto the vertebral column

Effects on long bones

- Usually compression & bending forces→complete, simple fractures without fracture lines

Effects on other bones

- Ribs
  - Tend to break in anterior (front/chest) end
- Vertebra
  - Simple fractures
  - Broken off processes
- Pelvis
  - Usually in pubis, iliac crest
- Scapula
  - Lots of fractures

Wound analysis

- Wound description
  - Placement
  - Type of fracture
- Force
  - Speed, weight, focus
- Sequence
  - Trace fracture lines
- Size of instrument
- Shape of instrument
- Direction of blows
- Number of blows
  - Multiple blunt force blows to the same area→flaking on the edge of the fracture
- Miscellaneous estimations
  - Car characteristics
  - Offender characteristics

Chapter 14 – Sharp trauma

Sharp force trauma

- Tends to be dynamic compression force
- Wastage
  - Chips of bone

Effects of sharp trauma

	Punctures	Incisions	Clefts
Cross section	V-shaped		
Width	Narrow/wide		Wide
Depth	Shallow/medium	Shallow/deep	Medium/deep
Length	Same as width	Short/long	Short/long
Striations	Vertical	Horizontal	Vertical
Fracture lines	May be present	Usually absent	May be present
Hinge fracture	May be present	Usually absent	May be present
Wastage	Minimal	Minimal	Significant

- Puncture
  - Direction is vertical/nearly vertical
  - Focus is cone shaped
  - Instruments that ends in a point
- Incisions
  - Defects are longer than they are wide
  - Applied across the surface of bone
  - Instrument is long with sharp edge
  - Slashing/stabbing that graze surfaces
- Cleft/notch
  - Vertically applied dynamic force
  - Instrument with long, sharp edge
  - Hacking actions

	Cleaver (butcher's knife)	Machete (long blade)	Ax
Entry site recognition	Clear	Less clear	Sometimes clear
appearance	Clean	Clean, chattering	Clean, shattering, crushing, fracture
width	Narrow (1.5mm)	Medium (3.5mm)	Medium-large (4-5mm)
fracture lines	Never	Stem from kerf floor	At entry site
Depth	Never through bone	Rarely through bone	Rarely through bone
Exit site recognition	None	Clear	Clear
fractures	None	Small-medium fragments	Large triangular bones
Striation	Fine, well-defined edges, parallel	Coarse, thick, rounded edge	None

Striation

- Run parallel to the direction of the applied force
- Sharp→small striation
- Dull→large striation
- SEM analyzes the microscopic characteristics of wounds to examine striation patterns

Wound analysis

- Wound description
  - Placement
  - Typue of wound
  - Size
- Instrument characteristics
  - Type
  - Blade
- Direction of force
  - Entry wound larger than exit wound
- # of wounds
- Sequence of wounds
  - Fracture lines are uncommon→usually can't be determined

Strangulation

- Hanging
  - Body is suspended by its neck using rope
- Ligature
  - Rope placed around the neck→tightened & help in place by force
  - More common in murder
- Manual strangulation
  - Throat is squeezed by hands until death
  - ~4mins
  - Homicide
- Hyoid bone
  - Free-floating bone that envelops the windpipe, superior to thyroid cartilage
  - Body + left & right horns
  - No strict fusing time
  - Young
    - Fracture is unlikely because horns not fused to body
    - Cause horns to fold inward
  - Probability of fracture increases with age because more likely to be fused
  - Fractures usually happen on 1 side
  - Most common in the middle and rear of the horns
  - 8% of hanging→break
  - 11% of ligature→break
  - 34% of manual strangulation→break
- Misdiagnosis due to hypoid bone
  - Break due to
    - Rough postmortem treatment
    - Poor excavation
    - Rough treatment during removal of remaining soft tissue
  - Many people's horns don't fuse to body

Chemical trauma

- Slow poisoning
  - Poison is deposited in the body tissues and occasionally bones

Chapter 15 – Antemortem skeletal conditions

Non-metric traits: traits no measured

Bone pathology

- Bones respond to pathology
  - New bone is added
    - Osteoblasts: form bone
  - Bone is taken away (resorbed)
    - Osteoclasts: destroy bone
- Disease must be chronic & present for a long time to be visible on bone
  - Not visible in kids

Deviation from norms

- Bones fail to ossify→opening in unexpected area
- Accessory ossicle
  - Single bone is divided into 2 or more segments
- Pathological conditions

Implications of deviation

- Mistaken for perimortem trauma
- Mistaken for postmortem damage
- Provide more information on decedents
- Aid positive identification

Pathological conditions

- Cause
  - Endocrine (hormones) disturbances
  - Nutritional deficiencies
  - Congenital deformities
  - Infectious disease
- Lytic lesions
  - Abnormal loss of bone, erosion, destruction
  - From small pores to large cavitation (pocket)
  - Untreated→anemia
- Proliferative lesions
  - Excess bone deposited at various locations
  - From small exostoses to large outgrowths
- Deformative lesions
  - Abnormal contours/shapes
  - Common for children with rickets (insufficient vitamin D)

Diseases that affect bones

- Dental
  - Calculus
    - Calcified plaque
  - Cavities
  - Gum disease
  - Abscess (body tissue swollen)
- Infectious
  - Leprosy
  - Tuberculosis
  - Syphilis
  - Osteomyelitis
  - Sinusitis
  - Ear infections

- Congenital (since birth)
  - Birth defect
  - Craniosynostosis (premature closure of the lambdoid suture)
  - Congenital hip dysplasia
- Joint disease
  - Osteoarthritis
  - Gout
  - Rheumatoid arthritis
  - Ankylosing spondylitis
- Endocrine
  - Dwarfism
  - Gigantism
  - Microcephaly (abnormal smallness of the head)
- Metabolic
  - Problems with digesting vitamins
  - Dietary deficiencies
  - Rickets (lack of vitamin D)
  - Flurosis (excessive intake of fluorine)
- Trauma
- Neoplastic (abnormal growth)
  - Tumors, cysts
- Circulatory
  - No blood flow→bone die off
  - Too much blood→bone growth

<u>Skeletal anomalies</u>

- Accessory ossicle
  - Extra bones in various parts of the skeleton
  - Most common to be mistaken for perimortem trauma
    - Separate ossicles within larger bones→appear to be caused by blunt trauma
    - Lost after death→opening→mistaken for gunshot wound
  - Irregular outline
  - Suture lines don't continue through these defects
  - No fracture lines
  - Round edges
  - If ossicles are missing, cortical bone can be seen on the inside edges
  - Womian bones
    - In lamboid suture
- Nonfusion anomalies
  - Retention of the metopic suture
  - Spondylolysis
    - Separation between vertebral arch & body
    - Unilateral/bilateral
  - Spina bifida
    - Non fusion of the sacral spine
  - Os acriomiale
    - Non fusion of the acromion in scapula
  - Sternal foramen
    - Non fusion of sternabrae segments
  - Bipartite patella
    - Ossification (turn into bone) of second layer of cartilage
    - Almost exclusively found in men
  - Os trigonum
    - Non fusion of posterior center of talus
- Accessory foramen (hole)
  - Extra holes in bone

- Miscellaneous anomalies
    - Trephination
        - Hole drillerd/scraped into the skull
        - Was used to treat intracranial disease
    - Pseudarthrosis
        - Joint created by the non-union of a fracture

Methods of pathological analysis

- Macroscopic/antroposcopic (small incision)
    - Examination with the naked eye
    - Endoscopy (tube with camera in digestive tract)
- Radiographic
    - CT scans or X-rays
- Microscopic
    - Histology (study tissue)
    - SEM (scanning electrons)
- Biochemical analyses
    - Look for biomarkers - treponemal disease, gout, plague
- Pathogen DNA
    - Tuberculosis, plague

Chapter 16 – Postmortem changes to the bone

- Study postmortem damage to differentiate from perimortem trauma & pathology
- Postmortem changes
    - Loss of bones/parts of bones
    - Cracks, pits, grooves & other marks
    - Modifications to bone shape
- Main sources
    - Human activity
    - Animal
    - Fire
    - Weather
    - Burial
    - Water

Dismemberment

- Function
    - Used by some cultures in mortuary ritual
    - Form of capital punishment
    - Now – almost always due to homicide
- Localized dismemberment
    - Only parts are dismembered→easy to transport/hide evidence
- Generalized dismemberment
    - All parts are dismembered especially joints
- Precise, clean cuts→experienced

Chiseling (saws)

- Hand saw
- Power saw
    - Straight
        - But on downstroke
    - Circular
    - Chainsaw
- Crosscut saw
    - Cut across the grain of material
    - Tooth edges at 70°
    - 5-12 teeth/inch
    - Eg. meat, hacksaw, carpenter
- Rip saw
    - Cut along the grain of material
    - Tooth edges at 90°
    - Chisel through material instead of cut
    - 3.5-7 teeth/inch
- Tooth set
    - Causes kerf (groove)
    - Teeth are bent laterally from the main axis of the blade→kerf wider than blade, to prevent binding while sawing
    - Teeth are triangles with unequal sides
        - Front is more vertical→can cut during push stroke
        - Backside slants more→allow easy movement during pull stroke

- Types of marks
    - Superficial false start scratches
        - Caused when blade is drawn across a bone
        - Usually on pull stroke & without much pressure
        - Near true kerf
    - False start kerfs
        - Caused by bouncing of the saw blade off the bone
        - During push stroke
        - Common with hand saws because hard to control blade until kerf is created
    - Sectioned bone cuts
        - Deep kerfs that indicate a number of strokes have been executed within the same groove
        - Most useful in determining saw type
- Striation
    - Caused by cutting action, on the wall of the cut
    - Power saw
        - Small teeth→uniform, fine striations
    - Hand saw
        - Irregular, more prominent striations
- Floor of kerf
    - Only visible in breakaway spur (residual spur)
        - Due to breakage in final cut
        - Usually in hand saw
    - Complete cut = no floor kerf
    - Coarse saw→rough (less teeth/inch)
    - Fine saw→smooth (more teeth/inch)

<u>Analysis of saw marks</u>

- Description
    - # of cuts
    - False start scratches & kerfs
    - Measurements
    - Location
- Direction
    - Direction of saw progress
        - Determined from location of false starts & breakaway spurs
    - Direction of saw stroke
        - Determined from exit chipping
- # of teeth
    - Determined from roughness of kerf
        - Rough=fewer teeth
- Blade width
    - Width of kerf/1.5
- Blade shape
    - Circular blades from power saws
        - Uniform, semicircular striations
    - Straight blades
        - Linear lines
        - Parallel
            - If not, indicate change of cutting direction
- Source of energy
    - Hand
        - Kerf wall uneven in flatness & direction
        - More striae

        - Beveled (slope) edges
        - Doesn't cut straight through material
    - Power
        - Smooth cuts
        - Polished walls
        - Straighter cuts

Animal scavenging

- Scatter bones
- Breakage through trampling
- Removal by chewing
- Caused by dog, dog-like animals, rats

Carnivore actions

- Punctures
    - Bone collapse under the force of carnivore tooth pressure
    - Often through thin sections of bones/ends of long bones
    - Share some characteristics with perimortem trauma BUT lack of fracture lines & presence of other injuries (pits, scoring & furrow)
- Pits
    - Don't penetrate through bone
    - Similar to those caused by sharp instruments with points
- Scoring
    - Scratches across the surface
    - Usually occur as a group of parallel lines
    - Most often on the shafts of long bones
- Furrows
    - Similar to scoring but deeper
- Secondary damage
    - Fracture lines
    - Splintering
    - Depressed fractures

Sequence of carnivore dismemberment

1. Soft tissues of head & neck
2. Ventral thorax opened & content of stomach & chest eaten→ sternum & rib ends
3. Upper limps, including scapulae & clavicles are separated from thorax
4. Lower limps removed from pelvis
5. Thorax removed from the area
6. Long bones separated from each other & chew ends
7. All bones articulated, scattered & chewed

Animal VS human dismemberment

- Humans don't
    - Remove scapulae & clavicles, just humerus
    - Remove femur from hip socket, just cut through femur
    - Separate parts of thorax

Rodents

- Chew marks on bones
- Estimate rodent size based on chew marks
    - Small – 1mm wide *eg. mice*
    - Medium – 2mm *eg.squirrels*

    - Large – 5mm *eg. beaver, porcupines*
- Don't really eat soft tissues & remove bones

Fire damage

- Colour change depending on temperature
    - Yellow
    - Brown
    - Black
    - Dark grey
    - Light grey/blue
    - White

Temperature	Color change	Shrinkage
Under 700	White, yellow, brown, gray, black	0-2%
700-800	White, gray, blue	1-3%
800+	White	5-25% (average 9.5%)

- Loose oils & fats→shrink
    - Hard to identify sex
    - Hotter→more shrinkage
- Calcination
    - Light weight & brittle fragility

Sunlight

- Heat→shrinkage
- Cracking, flaking, disintegration, warping

Burial damage

- Cracking & warping
- Erosion of cortical bone cause by acidity of soil
- Damage during recover/excavation

Chapter 17 – Additional aspects of individualization

Facial reproduction

- Methods
  - Sculpting clay to the appropriate soft tissue thickness on skull (3D)
  - Drawing soft tissues on a picture of the skull (2D)
- Purpose
  - Elicit the public's help to identify decedent
  - Will jog memory→positive identification
- Can't establish a positive identification by itself
- 50% lead to positive identification

Anatomical information

- Nose shape in correlation with nose bones
- Mouth & lip shape depends on size & shape of teeth, bite, jaw shape & projection
- Eye shape depends on orbital tubercle & lacrimal fossa
- Ear length = nose length
- Ear width = ½ nose length
- Ear position depends on mastoid & mandible

Manchester method – Richard Neave

- Anatomical + tissue depth
- Advantages
  - Use cast of skull
- Problems
  - Issues surrounding tissue depth
  - Requires anatomical knowledge
  - Time consuming & expensive

1. Reassemble fragmented skulls
   a. To apply clay
   b. Reveal healed trauma that could have changed the contour of a person's face
2. Mold & cast decedent's skull
   a. Maintain chain of evidence
      i. Original skull is available for further analysis
   b. Original skull may be too fragile
   c. Add in parts to incomplete skulls without damaging original skull
3. Obtain info on body build→determine tissue depth
   a. Thin – subtract 1 or 2 SD
   b. Obese – add 1 or 2 SD
4. Cut & place wooden dowels that correspond to thickness
5. Place in artificial eyes
   a. Protrude 16mm
   b. Corner of eyelids should be in line with the malar tubercle (border of eye)
6. Apply clay to simulate skin, fat, tissue, muscle
   a. Muscle marking helps determine thickness
7. Nose
   a. White – living width = opening width +12.2
   b. Black – living width = opening width x 1.63
   c. Depends on 2 measurements of pronasale (nasal tip)
8. Mouth
9. Last layer of clay simulate skin
   a. Conforms to the underlying soft & hard tissues
   b. Lessens their harshness & gives humanity

c. Epicanthic fold (fold over eyes)
    i. Asian – present
    ii. Native Americans – lesser expression
d. Fat pads under Asian eyes
e. Thick everted (outwardly turned) lips
    i. Black & some Asians – present
    ii. Whites, most Asians & Native Americans – thin lips

10. Ears
    a. Protrude outward/fold inward
    b. Attached/hang-free lobes
11. Wig
    a. Asian – straight black hair
    b. Whites – slight to medium wavy & light to dark hair
    c. Blacks – curled to strongly curled dark hair
    d. 50+
        i. Graying
        ii. Balding in Whites & Blacks
    e. Facial hair
        i. Males, particularly Whites

<u>Russian method – Mikhail Gerasimov</u>

- Anatomical method
    - Reconstruction of muscles, glands and fatty tissue based on skull markings
- Advantages
    - Not necessary to determine ancestry
    - Very realistic representations
- Problems
    - Requires extensive knowledge of soft tissue anatomy
    - Very tome consuming (2D + 3D process)
    - Requires lots of artistic skill
- Features
    - Relationship between face & skull shape
    - Thickness of soft tissue
        - Independent from ancestry
        - Nearly independent from age

1. Description of cranium
2. 2D reconstruction
3. 3D reconstruction for each half of face

American method – Wilton Krogman

- Tissue depth method
- Advantages
    - Can be produced relatively quickly
    - Doesn't require great deal of anatomical knowledge
- Problems
    - Determination of tissue depth
    - Ancestry-related tissue depth
    - Body type-related tissue depth
    - Can produce generic looking models

1. Determine sex, age & ancestry
2. Recreate tissue depths at 21 points
    a. Dependent on
        i. Sex
        ii. Ancestry
        iii. Geographic regions
        iv. Body type
3. Place tissue depth markers
4. Create & place prosthetic eye
5. Connect markers with sculpting material
6. Develop facial features

Estimate body weight

- Sex
    - Male heavier, more muscle
- Muscle markings
    - Indicates muscle size
    - Big=heavier
- Robusticity
    - Thick=heavier
- Height
    - Tall=heavier

Method to determine weight

- 1
    - Determine sex & stature
    - Consult standard heigh/weight charts
    - Account for skeletal robusticity
    - Judge by clothing size & other evidence
- Formula that determines from height

Chapter 18 – Obtaining an identification

Types of identification

- Tentative
  - Eg. credit card
- Presumptive
  - Biological information with picture
  - Eg. driver's license
- Positive
  - Skeleton & teeth match with antemortem medical & dental records
  - 100% certain

Unidentified people

- John/Jane Doe
- Baby Doe girl/boy

Radiography

- Problems
  - Distance of film must match in post & ante measurements
  - Side to side & top to bottom angles must match
  - Clarity in somewhat blurry to prevent damage on bone
- Frontal sinus
  - Male – larger
  - 5% don't have
  - 1% don't have left/right side (cells)
    - Separated by complete/partial septum
    - Cells vary in size & shape
  - Scalloping: upper border of cells
    - Unique to each person
  - Are cells symmetrical
  - Are cells in contact with each other
  - Cells separated by varying distances
  - Septum's degree of deflection
  - Degree of merging with ethmoid sinus
- Other sinuses
  - Ethmoid
  - Maxillae
  - Sphenoid
  - Mastoid processes
- Trabecular bone
- Brain sutures
- Bone that reinforces metaphyses of long bones
  - Its pattern is complex & affected by stress→unique to each person
- Pathological condition
- Rare antemortem condition
- Healed fractures
- Surgically/dentally implanted devices
  - Have unique number assigned by manufacturer

Forensic odontology procedure

- Human tooth?
- Class of tooth (incisor, canine, molar, pre-molar)
- Mandibular or maxillary
- 1^{st}, 2^{nd}, 3^{rd} molar? 1^{st} or 2^{nd} premolar/incisor?
- Left or right
- Ancestry
- Age
- Sex
- Postmortem interval
- Industrialized or non-industrialized
- Cause of death
- State of health

Forensic odontology

- 160 surfaces to record
- Ancestry

	Shoveled-shaped incisors	Cusp 7	Bushman Canine
White	8.4	5.8	4.8
Blacks	12.1	38.5	18.1
Asians	92.4	9.8	1.2
First Nations	85		

- Age
  - Tooth calcification
  - Emergence
  - Histological traits
  - Adult
    - Pulp stones (90% of 50+ people have)
    - Staining
    - Tartar→plaque
    - Tips of roots begin to close
- Sex
  - Crown length of 1^{st} & 2^{nd} molar
    - M – > 11mm
    - F – < 9mm
- Industrialized/non-industrialized
  - Non-industrialized
    - Heavy dental wear because harder diet
- Bruxism: grinding teeth
- Cause of death
  - Concussion
  - Subluxation (dislocation)
  - Etrusion (sticking out)
  - Intrusion (sticking in)
  - Avulsion (knocked out)
  - Enamel infraction (can break halfway through)
  - Enamel fracture
  - Complicated/uncomplicated crown fracture
  - Complicated/uncomplicated crown root fracture
  - Root fracture
  - Alveolar fracture
  - Gum wound
- Antemortem health
  - Enamel hypoplasia (enamel is hard but thin & deficient in amount)
- Positive identification
  - Inventory
  - Identify restoration
    - Amalgams (fillings)

        - Prosthetics (bridges)
        - Dentures (removable plate or frame holding one or more artificial teeth)
        - Crown (tooth-shaped cap)
    - Pathological conditions
        - Cavities
        - Cracks/breaks
        - Discoloration
        - Tatar buildup
    - Malocclusion
        - Bite type
            - Overbite
            - Underbite
            - Edge-to-edge bite
        - Spacing
    - X-rays
- Problems
    - Poor record keeping
    - Record error
    - Multiple dentists
    - Different coding methods
        - Zsigmondy/Palmer method
            - Separate in to 4 quadrants
            - Number teeth in each quadrant
        - FDI method
        - Universal method
            - 1-32

Chapter 19 – Conclusion

Ethical responsibility

- Respect
  - Remember the body was once a person
  - Respect decedent's family
- Confidentiality
  - Don't discuss details of a case until information has been made public
- Honesty
  - Realize that data has limitations→never provide information that can't be sustained by data

Responsibility regarding methods

- Must be up to date & keep up with literature

Evidence/opinion dichotomy

- Evidence
  - Data
  - Physical remains
  - Observations
- Opinion
  - Interpretation of remains based on methods used
  - Eg. based on right femur, height = 160cm
  - Speculation
    - Based on little/no data
  - Possible
    - More certain
  - Probable
    - Most certain

Ways to not overstate you opinion

- Omit statistics
  - Eg. 16-18 → late teens
- Word qualifiers
  - Eg. likely/unlikely, consistent/inconsistent

Mohan guidelines

- Expert testimony
- Subject matter must be beyond scope of jury/judge
- Need expert assistance to form correct judgment
- Experts must be properly qualified to testify on topic
- Theories & methods must be testable/tested, peer review, accepted, have standards

Final report

- Accurate
- Complete
- Show that anthropologist is competent & conscientious
- 1 page summary of skeletal analysis
  - Case #, date, investigators names
  - Condition of remains
  - Postmortem interval
  - Ancestry
  - Sex
  - Age at death
  - Stature
  - Trauma and unique skeletal characteristics

- Description of methods & detailed discussion of results
    - Background of case
    - General condition of remains in detail
    - Complete inventory
    - Demography: ancestry, age, sex, stature
    - Antemortem, perimortem, postmortem injuries
    - Recommendations for further testing (beyond scope of expertise/expertise of forensic anthropologist)
    - Appendices - photographs and tables

<u>Procedure of casework</u>

1. Request fee
    a. Establishes credibility
2. Establish & maintain procedures for maintaining chain of custody
3. Notes for every stage of analysis

<u>Phases of testimony</u>

1. Pretrial meeting
    a. Meeting with lawyer
    b. Figure out what you're going to say
    c. Scripted in advance
2. Establishing qualifications
    a. Determines whether you're an expert
    b. Provide qualifications to judge & jury
3. Direct examination
    a. Lawyer asks questions scripted in pretrial meeting
    b. Answer questions in a way everyone can understand
4. Cross-examination
    a. Opposing lawyer
        i. Asks you questions
        ii. Tries to criticize testimony
        iii. Find inconsistencies in your findings
        iv. Suggest your methods are incorrect
5. Redirect examination
    a. Lawyer on your side asks question to fix anything that went wrong during cross-examination

In court

	Whites	Blacks	Asians
Nose			
Root	High, narrow	Low, rounded	Low, ridged
Spine	High	Low	Low
Bridge	Pronounced	Small	Small
Lower border	Sharp	Guttered	Flat, sharp
Width	Narrow	Wide	Medium
Face			
Profile	Straight	Projecting	Intermediate
Shape	Narrow	Narrow	Wide
Eye orbits	Angular	Rectangular	Rounded
Lower eye border	Receding	Receding	Projecting
Chin	Pointed	Blunt	Rounded
Vault			
Browridges	Heavy	Small	Small
Muscle marks	Rugged	Smooth	Smooth
Vault sutures	Simple	Simple	Complex
Postbregma	Straight	Depressed	Straight
Jaws & teeth			
Jaws	Small	Large	Large
Palatal shape	U-shaped	Rectangular	Rounded
Upper incisors	Spatulate	Spatulate	Shoveled

	Males	Females
Size	Large & rugged	Small & smooth
Mastoid (behind ear)	Large, projecting	Small, nonprojecting
Browridges	Large	Small, none
Frontal	Slanted	High, rounded
Nuchal area (behind head)	Rugged with hook	Smooth, hook uncommon
Supraorbital margin (above eyes)	Rounded	Sharp
Chin	Broad	Pointed

<u>Stature</u>

- Full skeleton method
  - Skull height + vertebra height + length of femur & tibia + ankle height + correction factor of tissue
  - 11.7 + 0.996 x (sum of skeletal elements)
- Long limb bones
  - Total lengths of humerus, radius, ulna, femur, tibia & fibula

	Males	Females
Size	Large & rugged	Small & slender
Ilium	High & vertical	Low & flat
Pelvic inlet	Heart shaped	Circular/elliptical
Pubic shape	Narrow & rectangular	Broad & square
Subpubic angle	V-shaped	U-shaped
Obturator foramen	Large & ovoid	Small & triangular
Greater sciatic notch	Narrow	Wide
Preauricular sulcus	Rare	Well developed
Shape of sacrum	Long & narrow	Short & broad