Aids to Anatomy

Jack Joseph

Thirteenth Edition

Baillière Tindall

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Preface to the 13th Edition

A book which first appeared in 1876 and has had 12 editions and 26 reprints has proved its popularity with and value to many generations of medical students. In the 13th edition the basic and obviously successful format has been retained, and it remains a book on systematic anatomy without a section on osteology.

Much of the text has been rewritten and rearranged with parts added, especially on functional anatomy in relation to the joints. Many of the tables of relations of different structures have gone and have been replaced in a shortened form more suitable for modern teaching.

All the figures have been redrawn with standardized labelling. A few have been removed and 16 new figures added. Although the last edition introduced much of the new terminology, subsequent changes have made it necessary to bring this up to date, but where older names are still being used these have also been given.

Great care has been taken to make the headings and subheadings coherent and to use a clear typeface so that students can read the descriptions of the structures easily and solve the problem of remembering what they have tried to learn. Attitudes to topographical anatomy keep changing in medical education, but no one can deny the necessity and importance of a knowledge of the structures of the human body for understanding many aspects of medicine.

I would like to thank the publishers, and especially David Dickens and Cliff Morgan, for their cooperation in producing this new edition which I hope will continue to help the heavily burdened medical students over the early hurdles in their chosen profession.

Jack Joseph
London, August 1983

Contents

1
The Joints

A *joint* is the arrangement whereby separate bones or cartilages are attached to each other. Different kinds of joints can be classified either structurally or functionally.

Structural classification (Fig. 1)

Fibrous joints

The articulating surfaces are united by fibrous tissue continuous with the periosteum or perichondrium. Movement depends on the amount of fibrous tissue between the bones and varies from nil (e.g. sutures of adult skull) to a wide range (e.g. interosseous membrane of forearm).

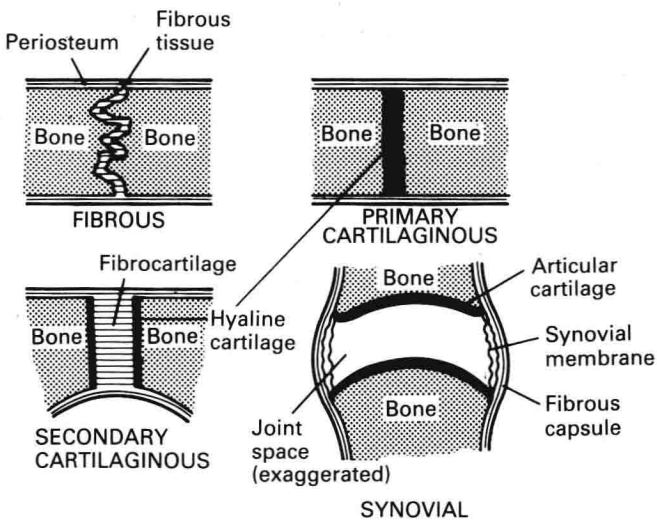

Fig. 1 Structural classification of joints (all joints are in section).

Cartilaginous joints

Primary cartilaginous: Bones are united by hyaline cartilage (e.g. the union of an epiphysis with the diaphysis). There is no movement.

Secondary cartilaginous (symphysis): Each articulating bone surface is covered with hyaline cartilage. The two cartilaginous plates are united by fibrocartilage which often contains a cavity. The cavity contains either a fluid like lymph (symphysis pubis, manubriosternal joint) or a gel (intervertebral disc). It never contains synovial fluid. There may be a limited amount of movement.

Synovial joints

Free surfaces covered with hyaline cartilage (except joints of clavicle and mandible). Enclosed in fibrous capsule. Capsule and all non-articulating surfaces lined by synovial membrane. Cavity contains a viscous synovial fluid secreted by the membrane. Movement varies from very little (e.g. sacro-iliac joint) to great freedom (e.g. shoulder, hip). Classified according to shape of bone surfaces e.g. *ball and socket, ellipsoid, condylar, saddle-shaped,* or type of movement, e.g. *hinge, pivot, gliding* (also called *plane*).

Functional classification

Freely movable joints—most synovial.
Slightly movable joints—symphyses. (These are permanent joints of movement.)
Immovable joints—*sutures* and *synchondroses*. (These are temporary joints of growth.)

In describing a joint the following systematic order is recommended:
(1) definition, type and articulating surfaces
(2) fibrous capsule and ligaments
(3) synovial membrane and bursae, if synovial joint
(4) nerve and blood supply
(5) movements and muscles producing the movements
(6) stability: factors are (a) bony, (b) ligamentous, (c) muscular
(7) important relations.

Development of joints

Condensations of mesoderm may ossify directly (*ossification in membrane*—e.g. flat bones of skull) or may chondrify first (*ossification in cartilage*—e.g. base of skull, long bones generally). Mesoderm between bones produces joint structures. Joint cavity results from disappearance of mesoderm. Perichondrium persists around joint cavity as capsule lined with synovial membrane. Cartilage persists over bone ends as articular cartilage.

During growth nutrient artery of shaft supplies down to cartilaginous growth plate. These are end-arteries. Epiphysis and capsule supplied by circulus vasculosus (of Hunter), lying between attachments of capsule and synovial membrane. No anastomosis between circulus vasculosus and nutrient artery of shaft until ossification of growth plate, at completion of growth.

Nerve supply of joints

Nerve to a muscle commonly gives sensory branch to joint on which the muscle acts, and to skin over joint (Hilton's Law). Nerves are associated with pain or movement (mechanoreceptors).

THE JOINTS OF THE VERTEBRAL COLUMN

Before birth whole column is concave forwards (*primary curve*). At about six weeks the head is held up and at about six months sitting up occurs. These produce forward convexities in the cervical and lumbar regions respectively. The latter becomes more marked on standing at about one year. These are called *secondary curves*. Thorax and sacrum retain primary curves.

The bodies of the vertebrae are united to one another by *intervertebral discs* which yield sufficiently to allow forward, backward and lateral bending and rotation of the column. This involves movement between the vertebral arches, so that there are synovial joints on each side between each pair of arches.

Joints of the bodies (symphyses)

These are secondary cartilaginous joints. The articulating surfaces are flat, except in the neck, where their edges are reciprocally bevelled and lipped and form small synovial joints (Fig. 2a).

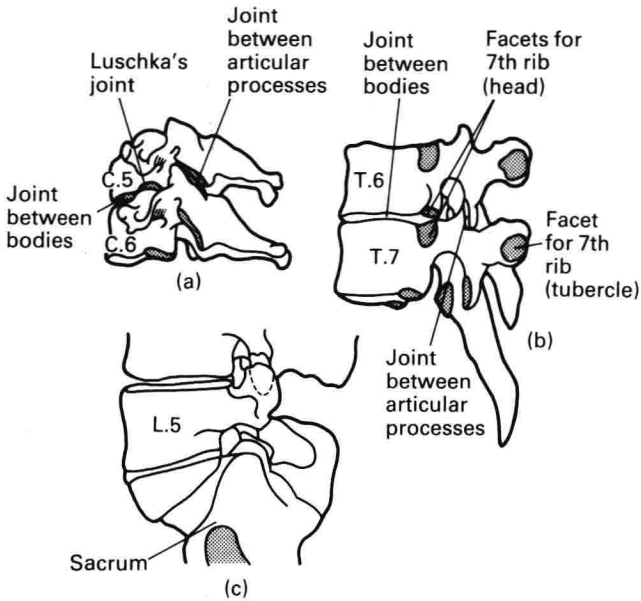

Fig. 2 Typical cervical, thoracic and lumbar vertebral articulations.

Intervertebral discs

The upper and lower surfaces of a vertebral body are covered by a plate of hyaline cartilage. The *anulus fibrosus*, uniting adjacent plates, is made of concentric layers of fibrous tissue. In each layer the fibres are parallel and slope at 45°. Alternate layers are at right angles to each other throughout the anulus. Slightly posterior to true centre of anulus is a gel, the *nucleus pulposus*, a remnant of the notochord. The gel resists loss of volume by pressure of

body weight, and centrifugal thrust of nucleus tends to stretch fibres of anulus.

Backward displacement of the nucleus pulposus or of injured disc tissue, causing pressure on the spinal cord or nerves, is a recognized clinical entity.

The *ligaments* are *anterior* and *posterior*, the more superficial fibres forming a continuous band. The anterior longitudinal ligament extends from anterior arch of atlas to sacrum, and the posterior longitudinal ligament from the body of the axis to the sacrum. Anterior longitudinal ligament broadens from above downwards and is adherent to periosteum of each vertebral body. Posterior longitudinal ligament is attached more firmly to discs than to vertebrae, and is wider opposite discs than opposite vertebrae.

Joints of the arches (zygapophyseal joints)

These are gliding synovial joints between the inferior articular processes of the vertebra above and the superior articular processes of the vertebra below.
The facets are arranged as follows (Fig. 2):

Region	*Shape and direction*	*Movement allowed*
Cervical	Flat. In same plane. Inferior process downwards and forwards. Superior process upwards and backwards.	Flexion and extension. Lateral flexion. Slight rotation.
Thoracic	Flat. On arc of circle. Inferior process forwards. Superior process backwards.	Limited flexion and extension. Rotation. Slight lateral flexion.
Lumbar	Inferior process convex and faces laterally. Superior process concave and faces medially.	Flexion and extension and lateral flexion. Limited rotation.

Movements. Head nodding (flexion and extension) and rotation occur at *atlanto-occipital* and *atlanto-axial joints.*

Elsewhere in column flexion and extension and lateral flexion are possible in all regions (range of each varies with region). Pure rotation possible only in thorax (limited by splinting effect of ribs). Lateral flexion (bending) in neck and thorax (not in lumbar region) accompanied by secondary rotation so that tip of spinous process rotates towards lateral convexity of curve (seen in scoliosis—lateral curvature of the spine).

Ligaments: (1) Capsular ligament of the above joints. (2) The laminae are connected by the *ligamenta flava*—thick, longitudinal, elastic bands attached above to the anterior aspect of the lower border of a lamina, and below to the posterior aspect of the upper border. (3) The spines are connected by weak *interspinous ligaments*, and their tips by a stronger *supraspinous ligaments*. In the neck, the *ligamentum nuchae* is a modification of these. It is not a stout elastic band in man, as it is in some quadrupeds, but a thin sickle-shaped intermuscular septum attached above to the occipital crest and below to the spinous process of the 7th cervical vertebra. Its deep edge reaches the spinous processes of the other cervical vertebrae; its superficial edge reaches the investing fascia over the posterior neck muscles. (4) *Intertransverse ligaments*, weak and thin, connect the transverse processes.

Special joints associated with movements of the head

The 1st cervical vertebra (atlas) articulates above with the occipital bone, and the joints between the atlas and axis (2nd cervical vertebra) are greatly modified to allow rotation of the head. These joints are in series with the lateral joints between the bodies of the cervical vertebrae (p. 4), not with the zygapophyseal joints of other vertebrae. The 1st and 2nd cervical nerves emerge behind the atlanto-occipital joints and lateral atlanto-axial joints respectively.

Atlanto-occipital joints (Fig. 3)
The articular surfaces are the upper, reniform, concave surface of the lateral mass of the atlas, and the convex occipital condyles. They are connected by a capsule. The

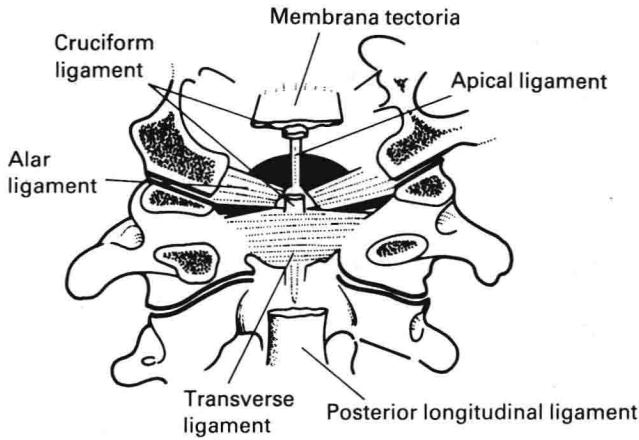

Fig. 3 Ligaments connecting the skull to atlas and axis.

anterior and posterior arches of the atlas are connected to the margins of the foramen magnum by the *anterior* and *posterior atlanto-occipital membranes*. The lower edge of the posterior atlanto-occipital membrane arches across the groove on the posterior arch medial to the lateral mass of the atlas. The vertebral artery with the 1st cervical nerve between it and the bone lies in this groove.

Movements: Flexion and extension. Lateral flexion. No rotation.

The stability of the atlanto-occipital joints depends on the skull being held down by ligaments connecting the skull to the axis, and by short muscles surrounding the joints (p. 67 and Fig. 26).

Atlanto-axial joints (Fig. 3)

(1) *Median:* The *transverse ligament* of the atlas, attached to tubercles on the medial aspect of the lateral masses, shuts off a small anterior compartment for the dens from a larger posterior containing the spinal cord.

The ligament lies in a groove on the dens. The dens projects into the anterior compartment and has a smooth

cartilaginous surface in front to form a synovial joint with a facet on the back of the anterior arch of the atlas. Similarly the dens is covered by cartilage behind and articulates with the front of the transverse ligament by an intervening bursa.

(2) *Lateral:* At the junction of pedicle with body the axis has a large oval facet facing upwards and slightly outwards. The inferior surface of the lateral mass of the atlas has a similar facet articulating with this by a synovial joint.

Movements: When the atlas rotates, carrying with it the head, the lateral mass slides forwards and backwards at this joint.

Running downwards and inwards from the back of the lateral mass to the back of the body of the axis is a thin but strong *accessory atlanto-axial ligament.*

Other ligaments connecting the skull to the axis: (1) The *apical ligament* from the tip of the dens to the anterior margin of the foramen magnum (remnant of the notochord). (2) The strong *alar (check) ligaments* connecting the sides of the dens to the medial side of the occipital condyles. (3) Bands stretching up from the back of the body of the axis to the transverse ligament and thence to the foramen magnum. These with the transverse ligament form the *cruciform ligament,* of which they are the superior and inferior bands. (4) The *membrana tectoria* is a broad band separating the cruciform ligament from the dura mater of the spinal cord—attached to the body of the axis with the posterior longitudinal ligament. Above it enters the skull through the foramen magnum to fuse with the periosteum of the basi-occiput. The spinal dura mater is adherent to the membrana tectoria.

Lumbosacral joints (Fig. 2)

The inferior surface of the 5th lumbar vertebra faces downwards and backwards, its body being a wedge narrow behind. This wedge supports the whole weight of the trunk

above, and has a tendency to slip forwards (*spondylolisthesis*). This is prevented by the more transverse direction of the joints between the inferior articular processes of the 5th lumbar vertebra and the superior articular processes of the sacrum, the thick intervertebral disc and the strong *iliolumbar ligaments*, from transverse process of 5th lumbar vertebra, backwards and downwards as well as laterally to iliac crest (Fig. 10).

Note: Vertebral joints are supplied by branches of the corresponding spinal nerves. These lie in the intervertebral foramen close to the lateral part of the joints between the bodies, the zygapophyseal joints and, in the cervical vertebrae, the small joints between the lateral edges of the bodies. Disease of any of these joints may affect the spinal nerve.

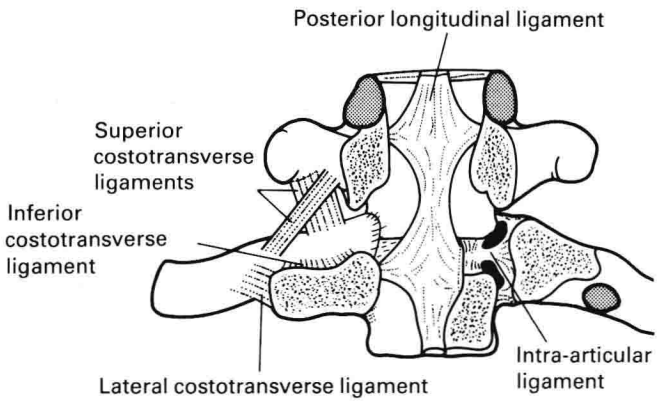

Fig. 4 Ligaments connecting rib to transverse process of a vertebra, joint cavity of head of rib and posterior longitudinal ligament.

JOINTS OF THE RIBS (Figs. 2 and 4)

A typical rib articulates posteriorly by its head and tubercle with the vertebral column; anteriorly the first seven costal cartilages articulate with the sternum, and the 8th, 9th and 10th with the costal cartilage above.

Joints of the heads of the ribs

From the 2nd to the 9th rib the head articulates with facets on the upper border of the corresponding vertebral body and the lower border of the vertebra above by a synovial joint. Between the two a ridge on the head of the rib is attached to the edge of the intervertebral disc by an *intra-articular ligament*. The anterior part of the capsule of the joint is reinforced by a *radiate ligament*, whose central limb crosses the midline. The first and the lowest three ribs articulate with only their own vertebral body.

Joints of the tubercles of the ribs (costotransverse)

The medial facet of the tubercle of ribs 1–10 articulates with a facet on the front of the corresponding transverse process by a synovial joint. The tubercle of the 11th and 12th ribs are attached by fibrous tissue to the transverse process of their corresponding vertebrae.

Costotransverse ligaments: (1) *Inferior costotransverse ligament* from back of neck of rib to front of transverse process (also called ligament of neck). (2) *Lateral costotransverse ligament* from lateral facet of tubercle to tip of transverse process. (3) *Superior costotransverse ligament* from upper edge of neck to lower border of transverse process above.

Joints of the costal cartilages with the sternum

First costal cartilage fixed by primary cartilaginous joint to manubrium; the two move as one and produce movement at the *manubriosternal joint*, a secondary cartilaginous joint which however synostoses as a rule after 40 years of age. Rigidity of 1st costal cartilage required for attachment of costoclavicular ligament to stabilize clavicle (p. 15) and thus whole of upper limb.

Segments of sternum (*sternebrae*) ossify separately. Costal cartilage articulates with upper and lower edges of adjacent sternebrae by synovial joint, divided into upper and lower compartments by small intra-articular ligament. As sternum ossifies, fusion of adjacent sternebrae is accompanied

by disappearance of intra-articular ligament. Hence in adult chondrosternal synovial joints are single cavities, except for the 2nd, where intra-articular ligament persists.

Summary

First chondrosternal articulation non-synovial throughout life. Second a bilocular synovial cavity throughout life. Third to 7th synovial cavities bilocular in infancy, unilocular after ossification of body is complete in adolescence, and tend to become obliterated in old age. Tips of 8th, 9th and 10th costal cartilages form synovial joints, each with costal cartilage above it.

Movements of the thorax in respiration

The ribs are pulled up possibly by the intercostal muscles and, because of their curves, increase the transverse diameter of the thorax; also, since they are directed obliquely downwards their elevation increases the anteroposterior diameter of the chest and pushes the sternum forwards. This is the *pump-handle movement*. This movement takes place about an axis through the head and tubercle of the upper ribs whose costotransverse joints are curves. The lower ribs move outwards in a *caliper movement* about a vertical axis through the neck of the rib. Their costotransverse joints are flat and the result is an increase in only the transverse diameter of the thorax.

TEMPOROMANDIBULAR JOINT (Fig. 5)

A synovial, condyloid joint between head of mandible, and mandibular fossa and articular tubercle on the inferior surface of temporal bone. Right and left joints are regarded as one joint. Each has a double joint cavity designed to allow the head to glide on the base of the skull and also to rotate round its long axis.

Articulating surfaces: Head of mandible with its long axis directed backwards and medially, is covered by fibrocartilage which extends on to back of condyle.

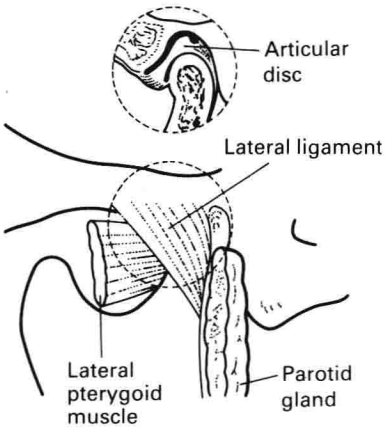

Fig. 5 Left temporomandibular joint seen from the side.

Mandibular fossa part of squamous temporal. The concave anterior surface of the tympanic plate is not part of the articular surface, and is occupied by parotid gland (see Fig. 5). The articular tubercle is covered with fibrocartilage, and is within the joint.

Capsule: Loose and superiorly attached anterior to the squamotympanic and petrosquamous fissures and in front of the articular tubercle. Below, the capsule is attached along the articular margin of the head of the mandible, and is strengthened laterally by the *lateral (temporomandibular) ligament*, whose fibres are directed from the posterior end of the zygomatic arch downwards and backwards to the neck of the mandible.

The *articular disc*, adapted to the bony surfaces, is attached all round to the capsule; it receives anteriorly fibres of the lateral pterygoid muscle which is also attached to the capsule.

Accessory ligaments: Two bands are usually described as additional ligaments of this joint: (1) *sphenomandibular ligament*, a flat band from spine of sphenoid to lingula and lower margin of mandibular foramen; (2) *stylomandibular*