ANT Sternum and sternal angle

Ni Anterior cutaneous branches of intercostal nn.

Aa Internal thoracic a.: sternal and perforating branches

Vv Internal thoracic vv.; parasternal lymph nodes

C Sternal marrow puncture; median sternotomy

Manubrium L T3–T4 vertebrae Ar Clavicles, 1st costal cartilages, part of the 2nd

Sternal angle M 2nd costal cartilage; T4–T5 disc P Superior/inferior mediastinum; ends of arch; tracheal bifurcation No Azygos v. joins the SVC; pulmonary trunk bifurcates

Xiphoid L Xiphisternal joint at T9 At Sternal part of the diaphragm, linea alba, rectus abdominis

LAT Ribs and costal cartilages

Ni Intercostal n. in the costal groove of each rib

Aa Posterior and anterior intercostal aa.

Vv Intercostal vv. to the azygos system and internal thoracic v.

T True 1–7; false 8–10; floating 11–12; arch: cartilages 7–10

Ff Inspiration: pump handle (ribs 2–6), bucket handle (7–10)

C Fracture just anterior to the angle; flail chest if segmental

Typical rib P Head (2 facets), neck, tubercle, angle, body Ar Head: own and superior vertebra; tubercle: own transverse process

First rib Fe Scalene tubercle; subclavian v. groove anterior, a. groove posterior R Neck: sympathetic trunk, supreme intercostal v. and a., T1 ramus

Costal groove C Intercostal v., a., n. (VAN), superior to inferior No Needles pass at the superior border of the inferior rib

POST Thoracic vertebrae and costovertebral joints

Ni Joints: dorsal rami of thoracic spinal nn.

Aa Posterior intercostal aa.: dorsal and spinal branches

Vv Vertebral venous plexuses to posterior intercostal vv.

C Compression fracture at the thoracolumbar junction

Thoracic vertebra Fe Heart-shaped body; long sloping spine; 3 costal facets At T1: full facet rib 1; T10–T12: single facets; T11–12: no transverse facet

Head joint T Synovial; rib head to two bodies and the disc L Radiate lig.; intra-articular lig. splits the cavity

Costotransverse joint T Rib tubercle to the transverse costal facet No Absent at ribs 11–12; superior and lateral ligg.

DEEP Intercostal muscles

Ni Intercostal nn.; subcostal n. (T12)

Aa Posterior (aorta) and anterior (internal thoracic) aa.

Vv Intercostal vv. with the arteries

L External, internal, innermost; bundle between the last two

Ff Accessory inspiration: SCM, scalenes, pectorals, levatores

External intercostal

O Inferior border of a rib

I Superior border of the next rib

F Elevates ribs: inspiration · Fibres inferoanterior; membrane anteriorly

Internal intercostal

O Costal groove of a rib

I Superior border of the next rib

F Depresses ribs: forced expiration · Fibres inferoposterior; interchondral part elevates

Innermost intercostal P Deepest layer, lateral part of the space No Layer with subcostales and transversus thoracis F As internal intercostals: depresses ribs, expiration

Transversus thoracis

O Posterior surface of the inferior sternum and xiphoid

I Costal cartilages 2–6

F Weakly depresses costal cartilages: expiration

DEEP Intercostal nerves and vessels

Ni Anterior rami T1–T11 = intercostal nn.; T12 = subcostal n.

Aa Posterior 1–2: supreme intercostal a.; 3–11: aorta · Anterior: internal thoracic (1–6), musculophrenic (7–9)

Vv Posterior vv. to azygos/hemiazygos; anterior to internal thoracic v.

Intercostal n. C Costal groove, between internal and innermost layers B Muscular, collateral, lateral and anterior cutaneous F Intercostal mm.; skin and parietal pleura of the space

Intercostobrachial n. Ar Lateral cutaneous br. of T2: skin of axilla, medial arm

Posterior intercostal aa. Ar Thoracic aorta, spaces 3–11 B Dorsal, collateral, lateral cutaneous

ANT Internal thoracic vessels

Ni Phrenic n. crosses the artery near its origin

Aa From the first part of the subclavian a.

Vv Internal thoracic vv. to the brachiocephalic v. · Parasternal nodes along the vessels: medial breast drains here

C Bypass graft: internal thoracic a. to anterior interventricular branch

Internal thoracic a. C 1 cm lateral to the sternum, posterior to cartilages 1–6 E 6th space: musculophrenic and superior epigastric aa.

Musculophrenic a. C Along the costal arch; anterior intercostal aa. 7–9

Superior epigastric a. C Sternocostal triangle to rectus sheath; meets inferior epigastric a.

INF Diaphragm and its openings

Ni Motor: phrenic nn. (C3–C5) · Sensory periphery: inferior intercostal and subcostal nn.

Aa Sup. and inf. phrenic, pericardiacophrenic, musculophrenic aa.

Vv Phrenic vv. with the arteries

L IVC T8, oesophagus T10, aorta T12

C Referred shoulder-tip pain (C4) from diaphragmatic irritation

Diaphragm

O Xiphoid, cartilages and ribs 7–12, crura, arcuate ligg.

I Central tendon

F Main muscle of inspiration

Right crus

O Bodies L1–L3; left crus L1–L2

I

F Encircles the hiatus: anti-reflux sphincter

Caval opening C T8, central tendon: IVC, right phrenic n. branches

Oesophageal hiatus C T10, right crus: oesophagus, vagal trunks

Aortic hiatus C T12, median arcuate lig.: aorta, thoracic duct, ± azygos v.

Pleura and recesses

Ni Parietal: intercostal and phrenic nn., pain-sensitive · Visceral: autonomic, pain-insensitive

Aa Parietal: intercostal, internal thoracic aa.; visceral: bronchial aa.

Vv Parietal: intercostal, parasternal nodes; visceral: bronchopulmonary

L Rib 8 midclavicular, 10 midaxillary, 12 paravertebral; lung 6, 8, 10

Ff Frictionless gliding; surface tension couples lung to wall

C Pleural tap: 9th space, midaxillary line, superior rib border

Parietal pleura P Costal, mediastinal, diaphragmatic, cervical

Cervical pleura P 2–3 cm superior to medial third of clavicle; suprapleural membrane

Costodiaphragmatic recess P Deepest recess; midaxillary line ribs 8–10; fluid collects here

Pulmonary ligament S Pleural fold hanging from the lung root

Lungs, lobes and fissures

Ni Pulmonary plexus: vagus constricts, sympathetic dilates bronchi

Lungs, lobes and fissures (cont.)

Aa Bronchial aa. nourish lung; pulmonary aa. bring blood to oxygenate

Vv Pulmonary vv. to the left atrium; bronchial vv. to the azygos system · Lymph: bronchopulmonary then tracheobronchial nodes

Ff Gas exchange; elastic recoil drives quiet expiration

C Pancoast tumour at the apex: Horner syndrome, T1 pain

Right lung L 3 lobes, oblique and horizontal fissures; 10 segments No Shorter and wider: right dome more superior

Left lung L 2 lobes, oblique fissure; 8–10 segments Fe Cardiac notch; lingula of the superior lobe

Apex P Into the neck, 2–3 cm superior to the clavicle R Subclavian a. grooves it; cervical pleura covers it

Oblique fissure M T2–T3 spine to the 6th costal cartilage; isolates the inferior lobe

Horizontal fissure M Right only: 4th rib and cartilage, midaxillary line to sternum

MED Root, hilum and mediastinal surfaces

Ni Phrenic n. anterior, vagus posterior to the root; pulmonary plexus

Aa Pulmonary a.: superior on the left, anterior on the right

Vv Pulmonary vv. most anterior and most inferior

Lung root L T5–T7 vertebrae C Bronchus, pulmonary a., 2 pulmonary vv., bronchial vessels, nodes, plexus

Right hilum Or Superior lobar bronchus eparterial; veins anteroinferior

Left hilum Or Pulmonary a. superior; bronchus posterior; veins anteroinferior

Right mediastinal surface G Right atrium, SVC, azygos arch, oesophagus, IVC

Left mediastinal surface G Left ventricle, aortic arch, descending aorta, left subclavian a.

Trachea and main bronchi

Ni Vagus and recurrent laryngeal nn.; sympathetic trunk

Aa Inferior thyroid and bronchial aa.

Vv Inferior thyroid vv.; paratracheal and tracheobronchial nodes

C Inhaled bodies enter the right main bronchus

Trachea E C6 (cricoid) to the sternal angle, T4–T5 F 16–20 C-rings keep airway open; trachealis narrows it

Carina P Internal ridge at the bifurcation C Widened by an enlarged left atrium or nodes

Right main bronchus Fe Shorter, wider, more vertical; azygos arch over it

Left main bronchus Fe Longer, horizontal; inferior to arch, anterior to oesophagus

Mediastinum and its divisions

Ni Phrenic nn. pass anterior, vagi posterior to the lung roots

Aa Aorta: ascending (middle), arch (superior), descending (posterior)

Vv SVC, brachiocephalic vv. (superior); azygos, thoracic duct (posterior)

P Transverse thoracic plane: sternal angle to the T4–T5 disc

Superior mediastinum C Thymus, great vessels, trachea, oesophagus, thoracic duct, nn.

Anterior mediastinum C Sternopericardial ligg., fat, nodes; thymus in children

Middle mediastinum C Pericardium, heart, roots of great vessels, phrenic nn.

Posterior mediastinum C Descending aorta, oesophagus, thoracic duct, azygos, vagi, splanchnic nn.

SUP Aorta and arch branches

Ni Left vagus and phrenic nn. cross the left side of the arch · Left recurrent laryngeal n. loops posterior to the ligamentum

Aa Arch: brachiocephalic trunk, left common carotid, left subclavian

Vv Left brachiocephalic v. crosses anterior to the branches

C Coarctation at isthmus: rib notching (intercostal collaterals)

Ascending aorta C Left ventricle to the sternal angle, in the pericardium B Right and left coronary aa. only

Aortic arch C Begins and ends at the sternal angle plane R Arches over the left main bronchus and pulmonary a.

Brachiocephalic trunk E Divides posterior to the right sternoclavicular joint

Ligamentum arteriosum J Arch to the left pulmonary a.: ductus arteriosus remnant

Thoracic aorta C T4–T12, left of the bodies, then midline at the hiatus B Posterior intercostal, subcostal, bronchial, oesophageal, sup. phrenic

POST SVC, brachiocephalic and azygos veins

Ni Right phrenic n. descends on the SVC

Aa Right posterior intercostal aa. cross posterior to the azygos v.

Vv Azygos: from right ascending lumbar and subcostal vv.

C SVC obstruction: azygos and thoracoepigastric collaterals

SVC C Formed at the right 1st cartilage; enters right atrium at the 3rd

Left brachiocephalic v. C Posterior to the manubrium, anterior to the arch branches

Azygos v. C Right of bodies; arches over right root to SVC at T4

Hemiazygos v. C Left side; crosses to the azygos v. at T9

R superior intercostal v. D Spaces 2–4 to the azygos arch

L superior intercostal v. C Crosses the aortic arch to the left brachiocephalic v.

Nerves of the mediastinum

Ni Phrenic C3–C5 somatic; vagus slows heart; trunk (T1–L2) speeds it

Aa Pericardiacophrenic a. runs with the phrenic n.

Vv Pericardiacophrenic vv. with the artery

C Left recurrent n. compressed by aneurysm or nodes: hoarseness

Phrenic n. C Anterior to the lung root, on the pericardium S Diaphragm (motor); pericardium, mediastinal, diaphragmatic pleura

Vagus n. C Posterior to the lung root; forms the oesophageal plexus S Right on the trachea; left crosses the aortic arch

Left recurrent laryngeal n. C Loops inferior to the arch at the ligamentum arteriosum F Motor: intrinsic laryngeal mm. except cricothyroid

Sympathetic trunk P On rib heads; white and grey rami to spinal nn.

Greater splanchnic n. C Ganglia T5–T9; pierces the crus to the coeliac ganglion F Preganglionic sympathetic to foregut viscera

POST Oesophagus, thoracic duct and thymus

Ni Oesophageal plexus (vagi) and sympathetic trunks

Aa Oesophageal brr. of thoracic aorta; left gastric a. inferiorly

Vv Azygos and left gastric vv.: portosystemic anastomosis

C Oesophageal varices in portal hypertension

Oesophagus C C6 to the cardia; posterior to the trachea and left atrium F Peristalsis carries the bolus to the stomach C Pharyngo-oesophageal junction, aortic arch, left bronchus, diaphragm

Thoracic duct C Aortic hiatus; between aorta and azygos v., posterior to oesophagus F Lymph and chyle of all but right upper quadrant E Crosses left at T4–T6; enters the left venous angle

Thymus P Superior and anterior mediastinum, posterior to the manubrium F T-lymphocyte maturation; involutes after puberty

Pericardium · sinuses

Ni Fibrous, parietal layers: phrenic nn. (C3–C5); visceral: pain-insensitive

Aa Pericardiacophrenic aa. (internal thoracic a.)

Vv Pericardiacophrenic vv. to brachiocephalic or internal thoracic vv.

C Tamponade: cavity fluid compresses the heart · Pericardial pain refers to the shoulder (C4)

Fibrous pericardium At Central tendon; sternopericardial ligg. F Anchors the heart; prevents sudden overdilation

Serous pericardium L Parietal lines the fibrous sac; visceral = epicardium F Serous fluid: frictionless gliding

Transverse pericardial sinus P Posterior to aorta and pulmonary trunk, anterior to SVC and atria No Clamp route in bypass surgery

Oblique pericardial sinus P Posterior to the left atrium, among pulmonary vv. and IVC

ANT External heart · surfaces, borders

Ni Cardiac plexus (sympathetic T1–T4, vagus)

Aa Right and left coronary aa. from the ascending aorta

Vv Cardiac vv. to coronary sinus, then right atrium

B Right: right atrium; left: left ventricle, left auricle · Inferior: right ventricle; superior: atria, great vessels

Apex of the heart Fo Left ventricle; left 5th intercostal space, midclavicular line

Base of the heart Fo Mainly left atrium; faces posteriorly, toward the oesophagus

Sternocostal surface Fo Mainly right ventricle

Diaphragmatic surface Fo Both ventricles, mainly left; on the central tendon

Surface sulci

Ni Coronary plexuses run with the arteries

Aa Coronary aa. and main branches lie in the sulci

Vv Coronary sinus: posterior coronary sulcus

Coronary sulcus C Right coronary a., circumflex branch, coronary sinus, small cardiac v.

Anterior interventricular sulcus C Anterior interventricular branch, great cardiac v.

Posterior interventricular sulcus C Posterior interventricular branch, middle cardiac v.

Crux of the heart P Meeting of coronary, interatrial, posterior interventricular sulci

SUP Great vessels · roots

Ni Left recurrent laryngeal n. hooks the arch at the ligamentum arteriosum

Aa Arch: brachiocephalic trunk, left common carotid, left subclavian aa.

Vv SVC, IVC to right atrium; four pulmonary vv. to left atrium

Ascending aorta C From the left ventricle, right of the pulmonary trunk B Right and left coronary aa. only

Pulmonary trunk C From the conus arteriosus; divides in the arch concavity

Ligamentum arteriosum At Left pulmonary a. origin to arch concavity; ductus remnant

Superior vena cava C Into the superior right atrium; azygos v. joins it

Pulmonary veins C Two each side, valveless, into the left atrium

LAT Right atrium

Ni Sinuatrial node in its wall (cardiac plexus input)

Aa Right coronary a. (atrial, sinuatrial nodal branches)

Vv Receives SVC, IVC, coronary sinus, anterior cardiac vv.

T Smooth sinus of venae cavae, rough pectinate part; crista between

Crista terminalis P Ridge from SVC to IVC; matches terminal sulcus F Atrial contraction; fast conduction from sinuatrial node

Pectinate muscles P Anterior wall and right auricle F Atrial contraction; strengthen the thin auricular wall

Fossa ovalis P Interatrial septum; limbus is its margin C Patent foramen ovale: interatrial shunt

Opening of the coronary sinus P Between IVC opening and right atrioventricular orifice

Triangle of Koch B Coronary sinus opening, tendon of Todaro, septal cusp; AV node

ANT Right ventricle

Ni Right bundle branch in the septomarginal trabecula

Aa Right coronary a.; anterior part from the left coronary

Vv Anterior cardiac vv. to right atrium; small cardiac v.

Conus arteriosus P Smooth outflow funnel to the pulmonary valve

Supraventricular crest P Separates rough inflow from the smooth conus F Deflects inflow into the cavity, outflow into the conus

Septomarginal trabecula At Septum to anterior papillary muscle F Right bundle branch shortcut to anterior papillary muscle

Papillary muscles of right ventricle P Anterior (largest), posterior, septal F Tense chordae in systole: no tricuspid eversion

POST Left atrium · left ventricle

Ni Left bundle branch, subendocardial, left side of the septum

Aa Left coronary a. (circumflex, anterior interventricular)

Vv Great cardiac v., posterior v. of left ventricle, oblique v.

C Enlarged left atrium indents the oesophagus (barium swallow)

Left atrium P Most posterior chamber; four pulmonary v. openings R Oesophagus posterior, across the oblique sinus

Left auricle P Left of the pulmonary trunk; its only pectinate muscles

Left ventricle W 2–3 times as thick as the right P Anterior, posterior papillary muscles F Pumps blood into the aorta · Papillary muscles tense chordae: no mitral eversion

POST Left atrium · left ventricle (cont.)

Aortic vestibule — P Smooth outflow part to the aortic valve

Interventricular septum — P Thick muscular; thin membranous near the aortic valve — C Ventricular septal defect: mostly membranous

Atrioventricular valves

Ni Cardiac plexus only

Aa Papillary muscles: coronary a. of their ventricle · Left posterior papillary muscle: often single supply, ruptures more

Vv Cusps nearly avascular; papillary muscles to cardiac vv.

Au Tricuspid: left sternal border; mitral: apex (both 5th intercostal space)

Tricuspid valve — P Anterior, posterior and septal cusps — F Stops backflow from right ventricle to right atrium (systole)

Mitral valve — P Anterior (next to aortic orifice), posterior cusps — F Stops backflow from left ventricle to left atrium (systole)

Chordae tendineae — At Papillary muscle tips to the cusp edges — F Hold cusps closed: no eversion into the atrium

SUP Semilunar valves · aortic sinuses

Ni Cardiac plexus only

Aa Coronary aa. open in right and left aortic sinuses

Vv Cusps nearly avascular; aortic root to cardiac vv.

Au Aortic: right 2nd intercostal space; pulmonary: left 2nd

Aortic valve — P Right, left, posterior (non-coronary) cusps; nodules, lunules — F Stops backflow from aorta to left ventricle (diastole)

Aortic sinuses — C Right and left coronary aa. open in their sinuses — F Diastolic backflow closes cusps and fills coronary aa.

Pulmonary valve — P Anterior, right, left cusps; top of conus — F Stops backflow from pulmonary trunk to right ventricle (diastole)

LAT Right coronary artery

Ni Coronary plexus

Aa From the right aortic sinus, into the right coronary sulcus · Right dominance (about 2/3): gives posterior interventricular branch

Vv Small cardiac v. with it; middle cardiac v. with posterior branch

S Right atrium, right ventricle, both nodes (usually)

Right coronary artery — C Between right auricle and pulmonary trunk; coronary sulcus to crux

Sinuatrial nodal branch — C Early branch to SVC opening and sinuatrial node (about 60%)

Right marginal branch — C Along the inferior border toward the apex

Posterior interventricular branch — C In posterior interventricular sulcus; septal branches

MED Left coronary artery

Ni Coronary plexus

Aa From the left aortic sinus, between pulmonary trunk and left auricle

Vv Great cardiac v. with anterior interventricular, circumflex branches

C Anterior interventricular branch: most often occluded

Left coronary artery — B Anterior interventricular and circumflex branches

Anterior interventricular branch — C In the anterior interventricular sulcus to the apex — B Diagonal and anterior septal branches

Circumflex branch — C In the left coronary sulcus around the left border — B Left marginal branch

POST Cardiac veins · coronary sinus

Ni No named nerves

Aa Veins follow the coronary branches

Vv Most to coronary sinus; anterior, smallest cardiac vv. open directly · Lymph: tracheobronchial and brachiocephalic nodes

Coronary sinus — P Posterior coronary sulcus; opens into the right atrium

Great cardiac vein — C Anterior interventricular sulcus, then left coronary sulcus

Middle cardiac vein — C Posterior interventricular sulcus to the sinus

Small cardiac vein — C With right marginal branch, then right coronary sulcus

Anterior cardiac veins — C Cross the coronary sulcus into the right atrium

Conducting system

Ni Sympathetic and vagal fibres reach both nodes

Aa Nodes: usually right coronary a.; bundle branches: septal branches

Vv Drains to the coronary sinus

Or SA node (pacemaker), AV node (delay), bundle, branches, Purkinje (spread)

Sinuatrial node — P Superior crista terminalis at the SVC opening — F Pacemaker: sets the heart rate (about 70/min)

Atrioventricular node — P Interatrial septum, apex of triangle of Koch — F Delays impulse: atria empty before ventricles contract

Atrioventricular bundle — C Right fibrous trigone to membranous septum; divides — F Only conduction route across the fibrous skeleton

Right bundle branch — C Septomarginal trabecula to the anterior papillary muscle

DEEP Cardiac plexus

Ni Sympathetic: cervical, T1–T4 cardiac nn.; vagal cardiac branches

Aa Lies on the arch and pulmonary arteries

Vv No veins of note

Ff Sympathetic: faster rate, stronger beat, more coronary flow · Vagus: slower rate, weaker beat

C Pain afferents run with sympathetic fibres to T1–T4: left arm

Superficial part of cardiac plexus — P Inferior to the arch, anterior to right pulmonary a.

Deep part of cardiac plexus — P Between the arch and the tracheal bifurcation