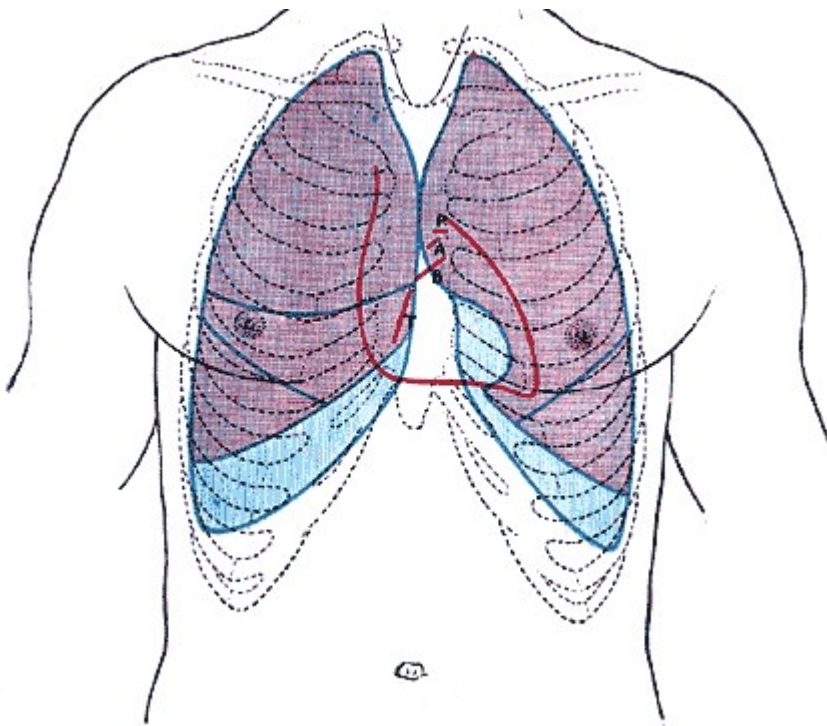


## Anatomy of the Torso: The Thorax

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**The human chest is a complex assembly of different osseous, ligamentary and muscular structures. It protects vital organs like the heart and lungs and is indispensable for the respiratory function. For medical students, it is advisable to learn the thorax in combination with the thoracic spine, as the thoracic spine and ribs form the rib vertebral joints and, therefore, you can save time studying, which may be urgently needed for other subjects.**



### The Thorax: General Information

The thorax is made up of about 70 individual components in total, each of which performs specific functions in order to maintain the overall system. Considered from an osseous point of view, the thorax consists of the **ventral sternum**, the **dorsal thoracic spine**, and the encasing pairs of ribs. Not all ribs have direct contact with the **sternum** but are connected to the ventral side of the thorax through cartilage plates.

The lower rib pairs neither have contact with the bone nor with the cartilage and, therefore, are called floating ribs. This is why it is important to distinguish between real pairs of ribs (with bone contact) and false pairs of ribs (with or without cartilage contact points). The ribs move in line with the breathing motion, due to their connection to the pleura plates and through the activation of the respiratory muscles.

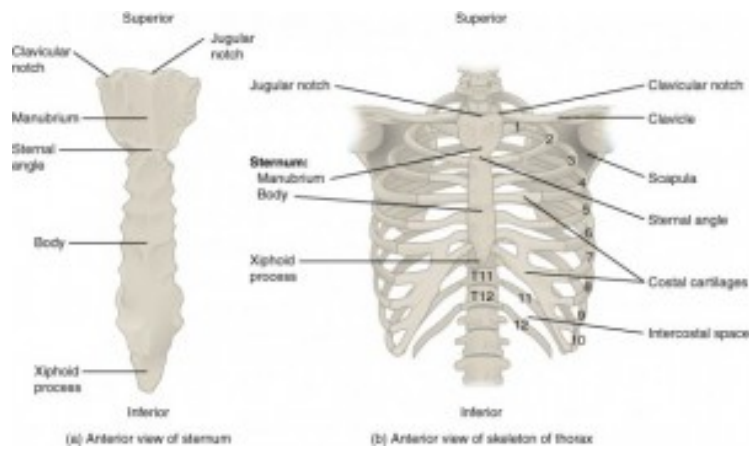


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## Osseous structures and articular surfaces of the thoracic spine

The thoracic spine forms the posterior side of the thorax and holds the osseous attachment points of the rib pairs. The **superior and inferior fovea costalis**, which articulate with the **caput costae** of the ribs, are found on the cranial departure points of the vertebral arch.

On the chest vertebrae 10-12, there is only one **fovea costalis**. The **fovea costalis** at the end of each transverse process connects ventrally with the **tubercle costae** of the ribs. With the exception of vertebral bodies 10-12, the joint surface is located in the middle of the **processus transversus**. At the **thoracic vertebra 10**, the articular surface shifts cranially, while it is entirely absent in the vertebral bodies 11 and 12.

## Osseous structures and articular surfaces of the ribs

The ribs are bone braces that ventrally merge into cartilage and either connect to the sternum and the ventral cartilage plate or, in the case of ribs 11 and 12, remain free. In medical terminology, the rib pairs 1-7 are called the **costae verae**; the rib pairs 8-10, **costae spuriae**; and the rib pairs 11-12, **costae fluctuantes**. The ribs themselves are divided into **caput costae**, **collum costae**, and **corpus costae**.

### Caput costae

The articular surface **capitis costae** is the one found at the **caput costae**. It is bisected by the **crista capitis**. The cranial articular surface is connected to the **fovea costalis inferior** of the vertebra immediately above, while the caudal articular surface touches the **fovea costalis superior** of the vertebra immediately below. The **caput costae** of the 11th and 12th rib has only one joint surface and forms a rib vertebral joint, dexter and sinister, together with the **fovea costalis** of the identical segment level.

### Collum costae

The **collum** follows the **caput costae** and ends with the **costae tubercle**, which contains the articular surface **tuberculi costae**. This connects with the **costal fovea transversalis** of the **processus transversus** of the **thoracic vertebra**. In addition, the

eight lower ribs contain the ***crista colli costae***, which serves as an insertion site for the ligament **superior costo- transversarium**.

## *Corpus costae*

Originating from ***tubercle costae*** and running to the ventral cartilage is the ***corpus costae***, which forms the ***angulus costae***. The intercostal nerves and intercostal vessels extend through the ***sulcus costae***, which is located on the inside of the dorsal section.

## Cartilage costal

The costal cartilage is the rib cartilage that increases in length from cranial to caudal and extends to the sternum in the cranial section. The seventh rib has the most prominent cartilage portion leading to the sternum.

## Osseous structures and articular surfaces of the sternum

The breastbone (sternum) forms the ventral boundary of the thorax and the chest wall. Cranially, it is wide and becomes narrower caudally, making it visually reminiscent of a sword or a spear point. From cranial to caudal, a distinction is made between the ***manubrium sterni***, body of the sternum, and the **xiphoid process**.

## Manubrium

On the top rim of the manubrium is the jugular notch. It extends laterally in the ***incisura clavicularis***, which articulates with the clavicles as the **sternoclavicular joint** (SCG). Following the bone caudo-laterally, next in line are the ***costal incisurae prima et secunda***, which correspondingly connect with the first and the second ribs. The cartilage-covered transition from the manubrium to the body of the sternum is called the **synchondrosis manubriosternal**. Here, the bone bulges forward and forms the ***angulus sterni***.

## Body of the sternum

The body of the sternum holds the insertion areas for the third-seventh rib pairs laterally, the ***incisurae costalis*** 3-7. At the end of the costal cartilage 7, the **synchondrosis xiphosternalis** connects the body of the sternum with the xiphoid process.

## ***Processus xiphoideus***

The 'sword tip' of the sternum is a narrow, thin bone ridge that forms the ***angulus infrasternalis***, also called the epigastric angle, with cartilages 7-10.

## The Thorax: Articulations

The variety of osseous components in this body area results in an equally large number of different articulated connections, which are often difficult to distinguish from one another by medical students and trainees in the therapeutic professions.

## ***Articulationes zygapophysiales***

The vertebral arch joints are real joints; each of them contains cartilage-covered joint surfaces and a joint capsule. They absorb compression forces and transmit them so that movements can be performed selectively and without injuries. The articular surface superior articulates with the articular surface inferior of the vertebra immediately above. The vertebral arch joints are further described in the anatomy of the spine.

## ***Articulationes costotransversaria***

The ***fovea costalis processus transversus*** contacts the **convex articular surface *tuberculi costae*** of the ribs at the ***processus transversi*** of the vertebral bodies. The articular surfaces of the ribs 1-7 are located ventrally of the eighth rib, slightly cranial to the transverse processus, while the free ribs have no contact with the ***processus transversus***. The joint capsule is thin and contains small ***synovial plicae***.

## ***Articulationes capitae costae***

The ***foveae costalis inferior*** and **superior** of the vertebra articulates with the articular surface *costae* of the ***caput costae***. The joint capsule of the 'rib head joint' is very thin and is merged with the ***ligamentum capitae costae radiatum***.

## ***Articulationes sternocostalis***

The ***articulatio (art.) sternocostalis*** describe the joint connections between the sternum and ribs. The articulating joint surfaces differ depending on the level. The ***articulationes interchondrales*** form a special feature where they connect the ribs 8-10 with each other and contain a capsule formed by the ***perichondrium***.

- ***Art. sternocostalis 1:*** The first rib joins the costal notch *prima* of the sternum.
- ***Art. sternocostalis 2:*** The second rib joins the costal notch *secunda* of the sternum.
- ***Art. sternocostalis 3-7:*** The ribs 3-7 connect to the *incisurae costalis 3-7* of the sternum.

## The Thorax: Ligaments

The ligaments of the thorax have to be divided into the ligaments of the **thoracic spine**, the **costovertebral ligaments**, and the **costosternal ligaments**. The ligaments of the **thoracic spine** are **ligaments longitudinal anterior** and **posterior**, **ligaments flava**, **ligaments supraspinale** and **infraspinale**, and **ligamentum transversum**. These are described in detail in the chapter on spine anatomy.

## Costovertebral ligaments

These ligament structures extend from the ribs to the spine.

## ***Ligamentum (lig.) costotransversarium laterale***

This ligament originates from the tip of the transverse process and inserts into the rib of the same segment level, where it merges with the joint capsule.

## ***Lig. costotransversarium superior***

The insertion points of this ligament are located at the **collum costae** (cranial) and at the lower edge of the transverse process of the vertebra immediately above.

## ***Lig. costotransversarium***

Originating from the dorsal surface of the **collum costae**, the **ligament costotransversarium** inserts into the transverse process of the **vertebra** of the identical segment level. This ligament is located just between the ribs 1-10 and not in the free pairs of ribs.

## ***Lig. capitis costae radiatum***

This ligament connects the **caput costae** with the **corpus** and **discus vertebrae** and is divided into three distinct fiber tracts with different courses of direction. The cranial fibers connect with the next higher segment, the caudal fibers connect with the next lower segment, and the horizontal fibers with the segment of the same level. This ligament is not present at the first rib nor at ribs 10-12.

## ***Lig. capitis costae intraarticulare***

As the name suggests, these ligaments extend intra-articularly and connect the **crista capitis costae** to the **annulus fibrosus** of the second to ninth ribs.

## Sterncostal ligaments

These ligament structures extend from the ribs to the sternum.

## ***Lig. sternocostalis radiatum***

Originating from the costal cartilage of the ventral sternum, this ligament extends fan-like and connects exclusively with the five cranial portions of the joint capsule.

## ***Lig. costoxiphoideum***

This ligament extends from the costal cartilage of ribs 6 and 7 to the **processus xiphoideus**. It is also connected to the ligament **sternocostalis radiatum**.

## The Thorax: Clinical Examples

The clinical features of the thorax are identical to that of the spine in certain examples, so the cases featured here are specifically relevant to the pathogenic changes in the ribs or rib joints.

## ***Pectus excavatum***



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**Pectus excavatum** is a congenital malposition or deformity. The **ventral thoracic** wall is deepened from the **manubriosternal synchondrosis** to the **processus xiphoideus**. Not every patient with this deformity actually displays symptoms. In cases of severe etiology, heart failure may occur as a complication and result in reduced vital capacity.

## *Sternales* stress disorder

In cases of lasting incorrect loading in kyphosis, the extreme mechanical stress causes the shoulder girdle to ventralize, and the costosternal joint to come under compression, for which they cannot compensate. The joint surfaces degenerate, and that can lead to pain in the lateral sternum in very severe cases, which is often wrongly mistaken for **angina pectoris** and consequently mistreated.

## Insertion ligamentopathy

The **lig. costotransversarium lateral** is particularly affected by this condition. The increased strain leads to arthritic changes in the **costovertebral joints**, whose inflammation parameters can be transferred to the ligaments. Consequently, these can also degenerate and that can, in turn, lead to ruptures if the disease progresses.

## Spondylitis ancylopoetica (Morbus Bechterew)

This **rheumatogenic-inflammatory disease** can affect the **costovertebral** and **costosternal joints**, in addition to the spine. Fibrosis and ankyloses occur, along with calcifications of the longitudinal ligamentous structures, resulting in a pathologic flexion. Thus, the thorax is constrained, and the respiratory motion is reduced. This is compensated into the stomach, which consequently bulges, so it is also referred to as the so-called abdominal football phenomenon.

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