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Research Article

Tashrīḥ-e-Jidār-e-Ṣadrī (Anatomy of the Thoracic Wall): An Osteological Perspective from Greek Origins to Arab-Islamic Medical Tradition

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Abstract: ***Introduction:*** Thoracic wall osteology represents a continuous intellectual evolution of Greco-Arab doctors and anatomists, and is essential for the development of modern anatomy. Galen's initial an anatomical descriptions of the chest wall define early concepts of the structure of the ribs, sternum and their articulation with the spinal column derived from dissections of animals. His explanations of rib mechanics and respiratory physiology were highly influential. Islamic Golden Age commentators like Ibn Sīnā (Avicenna), Al-Rāzī and Ibn al-Nafīs, refined and elaborated upon these ancient concepts. Ibn Sīnā, for example, integrated thoracic osteology into medical practice by discussing rib segmentation, articulation with the vertebrae and the sternum, and the protective and mechanical role of the thoracic cage. Ibn al-Nafīs brought critical revisions to accepted physiological ideas about, for example, cardiopulmonary circulation, to better conceptualise the functional relationship between the thorax's skeletal elements and its organs. These represent a shift from descriptive to inferential and functional anatomy studies. Overall, the Greco-Arab work on the osteology of the thorax not only built on traditional knowledge but also provided critical junctures that shaped developments at the advent of the Renaissance. This article explores the historical development of thoracic osteology, emphasizing the contributions of Greco-Arab scholars to anatomical knowledge. It highlights how their texts preserved and systematized osteological concepts, influencing European anatomical traditions and serving as a vital bridge in the evolution of thoracic anatomy and modern medical science.

Keywords: Thoracic Wall; Osteology; Tashrīḥ-e-Jidār-e-Ṣadrī; Unani Medicine; History of Anatomy

INTRODUCTION

The thoracic wall is a fundamental part of the human musculoskeletal structure that protects crucial organs, such as the heart and lungs, and enhances the mechanical actions needed for breathing. Ostologically, the thoracic wall is made up of the ribs, the sternum and the thoracic vertebrae, collectively known as the thoracic cage.[1][2][3]

These bones strike a dynamic balance between rigidity and flexibility, enabling the thoracic cavity to house, protect and allow movements of internal organs while also undergoing expansion and contraction during the act of breathing. Given its considerable importance, the osteology of the thoracic wall has been a subject of interest for physicians and anatomists as they pursued knowledge of the structure of the chest and its relevance to health and illness.[4]

Interest in anatomical study of the thoracic cavity is evident from early Egyptian and Greek ideas. Early anatomical and clinical understanding of the thoracic cage can be traced back to the times of the Edwin Smith Papyrus, and anatomical observations of vertebral injuries that result in neurological dysfunction are used to reflect an early awareness of its role and structure.[5] This knowledge was expanded by the Greeks, whose medical treatises, of the Hippocratic Corpus, discuss injuries and fractures of the ribs and chest diseases, showing an increase in clinical appreciation of its structure. This knowledge was elaborated on by Galen, who subsequently described the anatomy of the ribs, sternum and their joints with the vertebral column in a fashion that systematically defined the osteology of the thoracic cage that would stand for centuries in medical writing.[6]

In the early middle ages, Greek medical and anatomical concepts were relayed to Arab-Islamic medicine through a massive translation project whereby many scientific and medical texts were translated into the Arabic language. This allowed for the continued study and enhancement of classical medical ideas in new intellectual settings, like the learning centres of Baghdad.

Arab-Islamic physicians critically engaged with the knowledge of Greek anatomy in their encyclopedias of medicine. For example, thinkers such as *Al-Rāzī* and *Ibn Sīnā* drew on previous anatomical concepts in influential works, such as Kitab al-Mansuri and *Al Qanūn fī al-Tibb*, in which the anatomy and physiology of the thoracic region was described in the context of Greco-Arab medicine.[7][8]

Although these scholarly traditions have a rich history, little has been said about the evolution of anatomical knowledge of the osteology of the thoracic wall in Greek and Arab-Islamic medical texts. Historical scholarship on anatomy generally addresses broader theories, rather than developments in knowledge of specific anatomical structures. Thus, a targeted analysis of the thoracic wall osteology within these traditions can offer us vital clues about the way early doctors understood the structure of the thoracic cage and how the commentators' interpretations may have played a role in the preservation, continuity and dissemination of anatomical knowledge through cultures and epochs.

Objectives

- To trace the evolution of thoracic wall osteology from Greek to Arab-Islamic traditions
- To analyse the integration and modification of anatomical concepts
- To contextualize historical descriptions within modern anatomical understanding

MATERIALS AND METHODS

This is a comparative study based on consolidation of the information taken from classical Unani texts such as, Al Qanūn fī al-Tibb, Kitāb al-Umda fi al-Jarāhat, Kitāb al-Mukhtarāt fī al-Tibb, Kitāb al-Kulliyāt, Kitāb-al-Mansūrī, Kitāb al-Hāwī, and Kāmil-al-Sanā. In addition, relevant information was also extracted from contemporary academic sources, including, peer-reviewed journals, research papers and other contemporary books to provide additional evidence and a broader context to the traditional knowledge.
Literature was chosen for their relevance to thoracic osteology. A comparative study of the texts was done to reveal continuity, change and innovation.

LITERATURE REVIEW:

Unani physicians consider the thoracic wall from a morphological, physiological and humoral perspective. It is known as "Jidār-e-Sadr" or "wall of the chest". The thoracic wall is made up of the ribs, sternum, thoracic vertebrae, muscles and connective tissues of the thorax wall. [9]

Greek Foundations of Thoracic Osteology

The classical knowledge of the thoracic bones was greatly influenced by the early Greek anatomists, whose findings went on to influence Greco-Arab and Unani systems of medicine. *Buqrāt (Hippocrates)* (460-370 BCE) was one of the first to describe the clinical aspects of the thoracic cage, wherein he recognised the ribs as curved bones that articulate with the spinal column and discussed its involvement in thoracic trauma and respiratory diseases. In his book on joints and fractures, he referred to the clinical importance of rib injuries and their impact on breathing.[10][11] *Arastū (*Aristotle) (384-322 BCE) went on to add to anatomical knowledge by writing comparative anatomical treatises on animals. In books such as History of Animals, he elaborated that the thorax forms bony cage that protects the vital organs like the heart and lungs.[12] *Jalinūs* (Galen) (129-216 CE) later gave a more detailed description of osteology of the thorax and described the sternum, ribs and their cartilages, and how thorax is important for the protection of the vital organs and respiration. Galen's anatomical works became canonised for centuries and were subsequently handed down to later generations of Arab and Islamic physicians, and became an important foundation for later thoracic anatomy studies.[13]

The Greeks also sought to integrate clinical and functional aspects. They recognised the thoracic skeleton not only served a structural role, but effected cardiopulmonary function. The rib-vertebral junction was acknowledged as crucial for rib mobility while variations in rib size and shape were linked to injury risk.[14][15] While dissection of human cadavers was generally prohibited, the Greeks used meticulous investigation of animals drawing inferences about human anatomy using prescient observational skills. The ancient Greek writings were the foundation for later developments in the Arab-Islamic medical renaissance.
Overall, the anatomical teachings of the Greeks provided the intellectual and anatomical foundation for thoracic osteology. *Buqrāt (Hippocrates)* offered empirical observations focusing on protection and function, and Galen provided a classification and functional analysis of ribs, sternum and vertebrae. Their writings became a pivotal resource for subsequent Arab-Islamic scholars to help preserve and advance thoracic anatomical knowledge.

Transmission through the Translation Movement

During the Abbasid period (8th-13th centuries CE), transmission of Greek medicine, including knowledge on thoracic osteology, was revolutionised. The heart of this

achievements was *Baitul Hikma* (House of Wisdom), an intellectual and translation centre in which Greek knowledge was translated. Scholars like the physicians and translators *Ḥunayn Ibn Ishāq Al-'Ābādī* and his ilk were instrumental in translating Hippocrates' and Galen's anatomical treatises, enabling the transmission of anatomical knowledge to Arab-Islamic scholars.[16]

The translation movement did not simply translate, it interpreted and critically evaluated. These translators collated various Greek manuscripts, reconciled contradictions, and offered commentaries to help explain complicated anatomical descriptions, especially of ribs, sternum and vertebrae of the thorax.[17] This allowed the assimilations of classical texts by Arab-Islamic physicians who then adapted them tolocal medical practices in the Islamic world.

Moreover, the translation movement saw the genesis of original works. Academics combined their knowledge from dissections and clinical practise with translation studies to improve osteological classification and to improve the understanding of thoracic function. Consequently, the effort served simultaneously to transmit Greek knowledge and to stimulate independent investigation, thereby laying the groundwork for later advances in anatomy [7]

Arab-Islamic Contributions to Thoracic Osteology

Arab-Islamic physicians played a significant role in the development of thoracic osteology, maintaining, upgrading, and codifying anatomical knowledge from the Greek tradition and building on contemporary observations and medical treatises. *Abū Bakr Moḥammad Ibn Zakriyā Al-Rāzī* discussed the composition of the thoracic cage in *Kitāb-al-Mansoorī*, noting the characteristics of the sternum and ribs and their protective function for vital organs (heart and lungs) as well as their roles in respiration.

Thoracic cage and its components such as the sternum and the ribs, highlighting the protective role of the cage for vital organs (the heart and lungs) and its role in breathing mechanisms.[18] *'Alī Ibn Al-'Abbās Al-Majūsī*, further described thoracic anatomy in his book *Kamil al-Sanā al-Tibbiya* (The Complete Book of the Medical Art), where he explained the articulation of ribs with the vertebrae and sternum and the stability of the thoracic cage.[9] *Ibn Sīnā* (Avicenna) provided a more detailed account of the anatomy of the thoracic cage in his *Al Qanūn fī al-Tibb* (The Canon of Medicine), in which he described the number, shape, and junctions of the ribs and sternum as well as their physiopathological significance in protecting the thoracic organs and facilitating pulmonary function. [18,19]

Later scholars continued to elaborate on thoracic anatomy; for example, *'Alī Ibn Abī Al-Ḥazm Al-Qarashī (Ibn Al-Nafīs)* discussed the functional aspects of thoracic structures in relation to cardiopulmonary physiology in his commentary on Avicenna's Canon, linking the skeletal framework of the chest with respiratory and circulatory functions. [20,21]

Taken together, these authors contributed to the development of the study of thoracic osteology by synthesising effects of classical traditions with their own observations, which in turn contributed to the development of anatomical knowledge in the medieval Islamic world and to the subsequent development of anatomical studies in Europe. This body of work served to systematise the study of thoracic osteology in a meaningful way for clinical practice.

Osteology of the Thoracic Wall: Analytical Perspective

Al-Adla (Ribs)

Adla literally means defined region or circle hence is the name given to ribs or chest bones as they become a protective circle around a certain part. Buqrāt (Hippocrates) (460-370 BCE) considered the ribs to be the protective and mobile cage of the chest, with a protective respiratory function and susceptible to fracture. He also noted that the ribs articulate with the thoracic vertebrae (twelve in number), suggesting a recognition of their anatomical association with the ribs, and important function of the thorax, but not a morphological description. [22]

Jalinūs (Galen) (129–216 CE) noted that most animals possess twelve ribs, while eleven or thirteen occur only rarely. Each rib articulates posteriorly with a thoracic vertebra through a double joint (costovertebral and costotransverse) and anteriorly with the sternum, which itself is composed of multiple fused segments though appearing as a single bone.

The first seven ribs articulate directly with the sternum; the eighth attaches near the root of the xiphoid process, while the remaining four (false ribs) terminate laterally without direct sternal articulation. Jalinūs observed that the costal cartilages alter the direction of the ribs, turning upward toward the sternum, sometimes in a smooth curve, sometimes more angularly depending on the species.[13][23]

In Kitābul Mansūrī, Al-Rāzī (Rhazes) (865–925 CE) described the structure of the chest in relation to the ribs and sternum. He stated that the anterior part of the chest is formed by seven bones whose anterior ends are cartilaginous (ghudhrūfī). These extend from the throat region to the mammary area, and on palpation the region appears soft, as if no bone lies beneath it. On each side of the thorax there are twelve ribs which are curved, with the middle ribs being the longest. The first seven ribs articulate posteriorly with the vertebrae and anteriorly with the cartilage of the sternum (ʿaẓm al-qaṣ). The remaining five ribs do not attach directly to the sternum or its cartilage; therefore, they are referred to as the false or posterior ribs (aḍlāʿ al-kadhibah / aḍlāʿ khalf). [18]

Abū Sahl Masīḥī (10th century CE) discussed rib curvature and respiratory mechanics. He highlighted rib mobility as essential for the expansion of the lungs. He explained that the thorax comprises a total of thirty-seven (37) bones, including the ribs and the bones associated with them. On each side of the chest, there are seven (7) true ribs, which are convex in shape. One end of these ribs is anchored posteriorly into the vertebral column, while the anterior ends articulate with the sternum (ʿAẓm al-Qaṣṣ) through cartilaginous extensions (costal cartilages). On each side, there are also five (5) smaller ribs, which do not reach the sternum. These constitute the lower part of the thoracic cage. [24]

'Alī Ibn Al-'Abbās Al-Majūsī (Haly Abbas) (930–994 CE) described the ribs in detail, distinguishing them into long (true) and short (false) ribs, explaining their articulations with the vertebrae and the sternum, and emphasizing the structural importance of the costal cartilages. [19]

In Al Qanūn fī al-Tibb, Ibn Sīnā (Avicenna) (980-1037 CE) stated that the ribs constitute a cage around the chest cavity, which protects the respiratory organs and the upper parts of the abdomen. They are not a single bone, but are segmented, which ensures them with necessary mobility, lightness, and allows the thorax to accommodate it to additional need of breathing or of digestion in the form of distention. The presence of costal cartilages between the ribs allows greater flexibility and avoids damage to other structures. The superior seven ribs (on each side), being longer and stronger, articulate both with the vertebrae in the back and sternum in the front, thereby creating a solid cage around the vital organs, such as the heart and lungs.

However, the inferior five ribs are shorter, do not articulate with the sternum in the anterior aspect and subtly diverge to form a larger opening inferiorly. This enables the protection of the liver, spleen and other organs of the abdominal cavity from the back, while enabling the expansion of the stomach when filled. Anatomically, ribs are connected with both the transverse process and the body of the vertebra with a double-jointed articulation that allows secure attachment, coupled with flexibility. The last two pairs of false and floating ribs, being cartilaginous at the lower end, act as shock absorbers and protect the diaphragm and abdominal organs from trauma.[19][25]

ʻAẓm-al-Qass **(Sternum/Breastbone):**

ʿAzm al-Qass (The sternum), or anterior part of the thoracic cage, was mentioned by Greek philosophers, and later expanded on by Arab-Islamic Unani physicians. As time progressed, knowledge of its anatomy, articulations and functions evolved from simple observations to detailed anatomical descriptions. Jalinoos was the most prominent early anatomist to describe the sternum, emphasising that it was a composite bone (made up of sternebrae) and articulated with the ribs and clavicles. He also noted its role in protection of the heart. [13][23]

Al-Rāzī in his book *Kitābul Mansoorī* explained that the sternum is formed of seven bony parts which have cartilages at their ends and it runs from the throat down to the breasts. He observed that its anterior part is soft due to the cartilage. *Al-Rāzī* also stated the anterior portions of the seven upper ribs are connected to the sternum in a cartilaginous fashion while the other ribs are not, thus highlighting the sternum's role in the formation of the cage-like structure of the thorax.[18]

'Alī Ibn Al-'Abbās Al-Majūsī mentioned sternum (*Qaṣ or Istikhwān-i-Sarsīnah*) as a flat long bone in the middle of the chest that constitutes the anterior part of the thoracic cage in *Kamil al-Sanā al-Tibbiya* (Complete Art of Medicine). He stated that it is the middle attachment of the seven upper true ribs (through the cartilages) and hence completes the toric structure of the thorax. He stated that the sternum is initially made up of several cartilages that later strengthen and give flexibility to the chest cage during breathing while retaining its stability. He also pointed out that the lower part of the bone extends into a flexible cartilaginous extension (the xiphoid) that helps prevent damage to the heart, stomach and diaphragm by external pressure. Functionally, he highlighted sternum's protective function of thoracic organs, and its attachment for the ribs and muscles of respiratory and postural mechanics. [9]

In *Al Qanūn fī al-Tibb*, *Ibn Sīnā* (Avicenna) gave a beautiful account of the sternum. He explained that the sternum (the name he used for the sternum was either *qaṣ or sar-e-sīnah*) was not a single bone, but was made up of seven segments. He claimed that this was a conscious design because of the need to retain the softness of the sternum so as to facilitate its function in support of the organs of respiratory in expansion and contraction. These segments are partially cartilaginous in order to ensure that the slight motions of the thoracic cavity are in coordination with breathing, despite the fact that they are strongly articulated. *Ibn Sīnā* also mentions that the length of the sternal segments is linked to the seven anteriorly-attaching ribs for articulation to occur. He also notes a wide, cartilaginous portion (*khanjarī*) at the lower end of the sternum whose slanting edge provides a gradual transition between the bony sternum and soft parts of the abdomen. This inferior section is like a small cavity which encases the stomach and the soft organs below. Hence, in *Ibn Sīnā*'s view, the sternum is the central but soft part of the thoracic cage which serves a protective and harmonious role in the process of breathing. [19]

In *Kitābul Kulliyāt*, *Ibn Rūshd* reaffirmed Galenic and Majusian anatomy, describing the sternum as the anterior support for seven true ribs, while noting that the lower ribs do not reach the sternum.[26] *Ismail Jurjānī* (1042-1137 A.D.), in *Dhakhīra Khwārazm Shāhī*, described the

sternum as consisting of seven segments situated between the ribs and connected to them through firm joints that allow limited movement. He also noted the presence of a soft cartilaginous structure at the lower end of the sternum, shield-like in form, which serves to protect the delicate region of the upper stomach. [27]

In *Kitāb al- Mukhtārāt fī al-Ṭibb*, *Ibn Hubal al-Baghdādī* described the sternum as being composed of seven bones, firmly joined to one another through strong articulations. Structurally, these bones are spongy and porous, while some of their parts contain cartilaginous segments that allow slight movement, flexibility, and expansion during respiration. On the borders of the sternum is a wide, round cartilage known as the *ghudrōf-i-khanjari* (pseudolithic or hardened cartilage). This cartilage is situated in front of the stomach area, protecting the viscera.

One of the astonishing anatomical changes in the sternum - and this goes by recurrent clinical experience - is that while in general circumstances bones are covered with muscles and they exist on the fat underneath, the sternum has fat on the muscles in this particular case. The rational given for this positioning is the sternum is in front of the heart. The heart is a reservoir of warm vapours that are being exhaled and these minute vapours ascend and reach the sternum. In fact, bones have an absorptive property and these vapours dry and infiltrate the bone. Hence, there is a layer of fat on the surface of the sternum to maintain its substance, so that the sternum is not completely dried out, and lost its strength. [28]

Faqarat-i-Sadr (Thoracic Vertebrae):

Buqrāt referred to the thoracic vertebrae as the twelve vertebrae which constituted the backbone of the chest and their articulation with the ribs. He identified spinal pathologies (kyphosis, scoliosis) due to ageing and diseases, demonstrating the pre-understanding of the structure of the thoracic vertebrae and its pathological changes, without discussing its morphological characteristics specifically. [22][29]

Arastū (Aristotle) (384-322 BCE) Owing to his lack of anatomical detail, Arastu did not describe the thoracic vertebrae in detail in History of Animals. But he referred to the vertebral column as the axis of the skeleton and mentioned the perforation of the vertebrae and their arrangement to the back in a row to provide a support for the trunk. [12]

Jalinūs further described the thoracic vertebrae. There are twelve thoracic vertebrae, he described, which have heart-shaped bodies of the vertebrae, long and inclined downwards spinous processes, and costal facets for rib articulation. He also identified that the vertebral canal of this part is narrower and that the thoracic vertebrae are less free than the cervical vertebrae highlighting their importance in safeguarding thoracic organs and the process of respiration. [13]

Abū Bakr Moḥammad Ibn Zakriyā Al-Rāzī (Rhazes) reported that there are twelve thoracic vertebrae, all having strong well-shaped bodies to support the weight of the thoracic cage. *Al-Rāzī* found thoracic vertebrae as the section firmly joined by costae. [18]

'Alī Ibn Al-'Abbās Al-Majūsī (Haly Abbas) adds that those are closely connected to each other by strong joints and ligaments that permit some set of controlled movement. He draws attention to the progressive enlargement in size from T1 to T12, and accounts for this as a response to support the weight of the thorax, transmit forces and ensure the integrity of the thoracic cage. All the while, Majusi also notes the thoracic vertebrae's role in connecting the ribs which allows adequate protection of the heart, lungs and other structures of the chest, without impeding necessary trunk movements such as flexion, extension and rotation. [9]

The most detailed medieval description was by *Ibn Sīnā*. He stated that the thoracic vertebrae:

The thoracic vertebrae are twelve and each one of them is connected with a rib to form the thoracic cage. Their spinous processes are differently sized and those that are found closer to the organs of life (heart, large vessels etc.) are larger, stronger and point downwards for added protection. Thoracic transverse processes are stronger and larger than cervical and lumbar transverse processes as they partake in the costo-transverse joint. Both the spinous and transverse processes of the upper seven thoracic vertebrae are strong. This enhances stability and protects this area and organs. The vertebrae's body extends towards these processes causing the short and broad articular processes.

With the exception of the tenth vertebra, the superior articular processes are flat and project upwards and contain condyloid fossae, while inferior articular processes project downwards into these narrow fossae, which aid the stability of the thoracic region. The tenth thoracic vertebra stands out for its dome-shaped spinous process and its articular processes, which do not contain condyles owing to the fact that it is firmly wedged between the ninth and eleventh vertebrae allowing for stability but with limited mobility.

The twelfth thoracic vertebra is also special. Due to the diminutive size of the twelfth rib, there is no transverse process. Instead, it has enlarged and doubled articular processes similar to those of Lumbar vertebra. This serves to strengthen the vertebra, and also serves as an origin for one crus of the diaphragm. The rest of the vertebrae in the thoracic spine don't need to be reinforced like this, and so their structure is strengthened by larger spinous and transverse processes, rather than a plethora of articular processes.

Intervertebral foramina of the thoracic region show a gradual change in their structure: in the upper thoracic

vertebrae, the foramen is divided into two parts, the lower part of the foramen is contributed by the upper vertebra. As the spine progresses down, the foramen moves until, at the level of the tenth vertebra, it is entirely contained by a single vertebra. Finally, in the lumbar region, each vertebra has its own independent foramina on both sides for the exit of the spinal nerves.

In summary, the different adaptations of the thoracic vertebrae, which include articulation with ribs, protection of the vital organs and changes into the lumbar region, are related to their function; they support the supporting the thoracic cage, the protection of organs, mechanics of respiration and weight-bearing. [25][30]
Ibn Rūshd (Averroes) (1126–1198 CE) recognised and documented that the thoracic spine is formed by 12 vertebrae, each contributing to the structure of the rib-bearing region. [26] *Ibn al-Quff* (1233–1286 CE) described the vertebrae of the back (thoracic vertebrae) as larger and thicker than the cervical vertebrae, while their cavities are comparatively narrower. He explained that the increased size and thickness of these vertebrae are necessary because they support the vertebrae located above them. The relative narrowness of their cavity is due to the fact that the portion of the spinal cord passing through this region is comparatively thinner, which results from the emergence of numerous nerves from it. He also pointed out that there is a single backward projection from the posterior end of each thoracic vertebra and is known as the spinous process (*Sin*). Moreover, the cervical, thoracic and lumbar vertebrae each have four articular processes: two are superior and two are inferior. He said the ten of these vertebrae have additional projections (*Ajniḥa*). He said this is because the ribs attached to them are not completely formed in length; hence a greater portion of it becomes a part of the articular process. The mass of these vertebrae would have doubled if they contained other transverse projections also. [31]

All the data was entered and analyzed in SPSS version 26. Quantitative data was calculated as mean $\pm$ S.D. Qualitative data was calculated as frequency and percentage. Data was stratified for age, gender, smoking, diabetes mellitus (BSR > 200 mg/dL) and hypertension (BP> 130/90). Post stratification hyponatremia and its severity was compared using chi-square test taking p value $\leq$0.05 as significant.

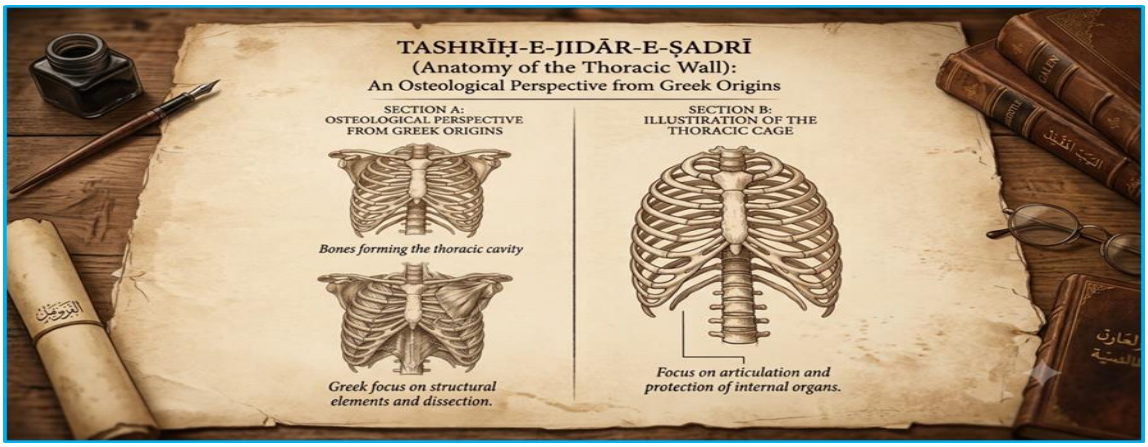

Figure 1

Figure 2

4.4.4 Functional Integration

Buqrāt (Hippocrates), in his works such as On Fractures and On the Articulations, described the ribs as curved bones attached to the vertebral column and discussed rib injuries and thoracic trauma, recognizing their clinical importance in respiration and protection of thoracic organs. Arastū (Aristotle), in History of Animals, used comparative anatomy to explain the structural arrangement of thoracic bones and highlighted the rib cage's protective framework for the heart and lungs. Jalinūs (Galen), in On the Usefulness of the Parts of the Body, provided detailed descriptions of the sternum, ribs, and their cartilaginous attachments, and explained how rib movements contribute to thoracic expansion and contraction during respiration. Al-Rāzī, in Kitāb al-Manṣūrī, described the structure of the sternum and ribs and their anatomical relations with thoracic muscles, stressing the functional relationship between thoracic bones and the muscles responsible for chest expansion and contraction.

'Alī Ibn Al-'Abbās Al-Majūsī (Haly Abbas), in Kāmil al-Ṣinā'ah al-Ṭibbīyah (The Complete Book of the Medical Art), presented systematic anatomical descriptions of the thoracic cage, including ribs, sternum, and vertebrae, and emphasized the protective role of the thoracic skeleton and its contribution to respiratory mechanics. Ibn Sīnā, in Al Qanūn fī al-Tibb (Canon of Medicine), integrated earlier Greek anatomical knowledge and described thoracic bones and their articulations, portraying the thoracic cage as a structural support protecting vital organs while assisting respiration. Ibn al-Nafīs, in Sharh Tashrih al-Qanūn, provided anatomical commentary on earlier texts and clarified the structure of thoracic organs and bones, linking thoracic skeletal structure with respiratory physiology and furthering functional interpretation of the rib cage.

DISCUSSION

The evolution of the osteology of the thoracic wall is an intriguing saga of observation, preservation and refinement across cultures. The concepts were pioneered in the Greek world, in particular *Buqrāt* and *Jalinūs*, who focused on the protective nature of ribs, sternum and thoracic vertebrae, as well as the principal functional roles. But their understanding was limited by their inability to dissect cadavers, sometimes resulting in errors. Arab-Islamic scholars, through the benefits of the translation movement and the milieu of critical inquiry in their culture, both preserved and added to this legacy through classification, observation and clinical knowledge. *Al Qanūn fī al-Tibb* and *Kitāb al-Hawī* are good examples of this transmission and innovation, incorporating both anatomy and medicine early in the process. This legacy highlights the power of interdisciplinary investigation to turn sparse observations into a deep, lasting anatomical understanding - a legacy that shapes both the history of anatomical study and contemporary anatomical instruction.

CONCLUSION

Thoracic wall osteology's history demonstrates an intellectual evolution through teaching and learning. Anatomical knowledge has evolved from Greek simplification to Arab-Islamic embellishment via critical discourse and observation. This tradition persists in contemporary medicine and stresses the need for cross-cultural communication in academia.

Conflict of Interest

The authors declare that there are no conflicts of interest to disclose in relation to the publication of this manuscript.

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Ethical Considerations

As this is a literature-based study, no human or animal subjects were involved, and thus no ethical clearance was required. However, due academic integrity was maintained through proper citation and referencing practices.

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