
Cross-Sectional Analysis of the Chest and Abdominal Wall

Richard J. Wechsler

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Richard J. Wechsler, M.D.

Director of Computed Body Tomography
Department of Radiology
Thomas Jefferson University Hospital
Philadelphia, Pennsylvania



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Project Manager: Mark Spann

Designer: Kay Michael Kramer

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Preface

Over the last decade cross-sectional imaging modalities (CT, MRI, and ultrasound) have assumed major diagnostic importance in the evaluation of the chest, abdomen, and pelvis. These modalities detect traumatic, inflammatory, congenital, and neoplastic conditions, allowing physicians to diagnose and to determine the extent of a pathological process. They also offer exquisite anatomical detail. Whenever a particular organ is imaged on CT or MR, not only it but surrounding structures are visualized, whether they are peritoneal or retroperitoneal, bone or muscle, vascular or ligamentous. Thus, when a defect in the renal pelvis is evaluated, the liver, adrenals, aorta, inferior vena cava, pancreas, second lumbar vertebrae, paraspinal muscles, and abdominal fascia can also be evaluated.

Although much has been written on chest, abdominal, and pelvic cross-sectional imaging, there has been a paucity of literature on imaging of the chest and abdominal walls. This is understandable because primary disease in these regions is not as common as disease in the visceral organs. However, pathological processes that start in the chest, abdomen, or pelvis often spread to the body wall. This is exemplified by tumors that spread to the gluteal region from the pelvis through the sciatic foramina or by posterior mediastinal abscesses that spread to the thigh via the iliopsoas muscle.

The focus of this book is on cross-sectional anatomy of the chest and abdominal wall. It concentrates on body regions that are often imaged during other examinations but about which little is written. These regions include the axilla, thoracic inlet, paraspinal muscles, and buttocks. Following a description of the anatomy of these regions, the major pathological processes that affect these regions are described. Special attention is paid to those processes unique to the body wall, such as abdominal wall hernias, decubitus ulcers, and lesions of the major nerve plexi.

The purpose of this book is not to describe every pathological entity that occurs in these regions. The major tumors involving the body wall are described; however, not every single tumor involving each region is described in each chapter. In addition, imaging protocols for each pathological process are not emphasized, mainly because many of these

pathological processes are detected serendipitously while examining the lungs, peritoneum, or retroperitoneum. Instead, the major focus of this work is on morphology and anatomical pathways. As cross-sectional imaging techniques become increasingly sophisticated, anatomy and pathways become increasingly important.

This monograph is aimed at those individuals primarily involved in cross-sectional imaging. They include residents, radiographers, and general radiologists. I hope that chest, abdominal, and orthopedic radiologists will also have an interest in this book since they may be the first ones to detect abnormalities of the chest and abdominal wall.

Richard J. Wechsler

Acknowledgments

Writing a book is never accomplished alone. The seed to this book was planted during my residency and fellowship at New England Medical Center Hospital under the tutelage of Robert Paul and Barbara Carter. Dr. Carter taught me the importance of anatomical detail in analyzing cross-sectional images. My first published paper, co-authored with Dr. Carter, was on the abdominal wall.

My gratitude also extends to my fellow staff, technologists, residents, and fellows for helping me in a multitude of ways in the preparation of this monograph. Special thanks are to my past chairman, Dr. Jack Edeiken, who allowed me a sabbatical to write this book and to Dr. David Levin, my present chairman, for his constant support and encouragement.

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Richard J. Wechsler

Contents

CHAPTER ONE

The Axilla and Supraclavicular Fossa, 1

CHAPTER TWO

The Thoracic Wall, 52

CHAPTER THREE

Anterior Aspect of the Abdominal Wall, 126

Pathways to the Scrotum, Peritoneum, and Retroperitoneum

CHAPTER FOUR

Posterior Aspect of the Abdominal Wall, 203

Pathways from the Posterior Mediastinum to the Thigh

CHAPTER FIVE

Paraspinal Musculature, 251

CHAPTER SIX

Gluteal Imaging, 287

A Retrospective Look

CHAPTER ONE

The Axilla and Supraclavicular Fossa

KEY TO ANATOMIC STRUCTURES ILLUSTRATED IN THIS CHAPTER

- | | |
|---|---|
| 1. Sternocleidomastoid muscle | 15. Pectoralis minor muscle |
| 2. Anterior scalene muscle | 16. Teres major muscle |
| 3. Middle and posterior scalene muscles | 17. Subscapularis muscle |
| 4. Levator scapulae muscle | 18. Serratus anterior muscle |
| 5. Trapezius muscle | 19. Subclavius muscle |
| 6. Omohyoid muscle (inferior belly) | 20. Axillary artery |
| 7. External jugular vein | 21. Axillary vein |
| 8. Internal jugular vein | 22. Latissimus dorsi muscle |
| 9. Common carotid artery | 23. Thoracodorsal vessels |
| 10. Transverse cervical vessels | 24. Lateral thoracic vessels |
| 11. Vertebral vessels | 25. Internal thoracic muscles |
| 12. Subclavian vein | 26. Coracobrachialis and biceps brachii muscles |
| 13. Subclavian artery | 27. Suprascapular vessels |
| 14. Pectoralis major muscle | 28. Longus colli muscle |

Palpation of the axilla and supraclavicular fossa is an essential part of a thorough physical examination because these anatomic compartments are involved in a variety of pathologic conditions. Axillary and supraclavicular adenopathy is a harbinger of many systemic diseases originating in the upper extremity, thorax, abdomen, or pelvis. However, clinical examination often fails to detect significant pathologic findings in many patients. For this reason, cross-sectional techniques are extremely valuable. This chapter reviews normal anatomy and its relation to pathologic processes.

AXILLARY ANATOMY

The axilla comprises more than the visible armpit. It contains the great vessels and nerves of the upper extremity. The axillary lymph nodes drain lymphatics from the arm, thoracoabdominal wall, and breast. Diseases of these organs cause axillary lymphadenopathy.

Anatomically, the axilla has the form of a truncated pyramid with the apex directed into the root of the neck among the subclavius muscle, clavicle, and first rib. The base of the axilla is formed by the axillary fascia, which crosses from the thoracic wall, the pectoral muscles, and the latissimus dorsi to the deep fascia of the arm.*

Muscular Walls of Axilla

The anterior wall of the axilla consists of the pectoralis major, subclavius, and pectoralis minor muscles along with the clavipectoral fascia and suspensory ligament of the axilla (Figures 1-1 and 1-2). The pectoralis major is a thick, fan-shaped muscle arising from the medial half of the clavicle, the sternum, the upper six costal cartilages, and the external oblique aponeurosis. Its fibers converge into a bilaminar tendon that inserts into the crest of the greater humeral tubercle. The pectoralis major flexes, adducts, and rotates the arm medially. The subclavius is a small, cylindric muscle arising from the first costal cartilage, running between the first rib and clavicle, and inserting on the inferior surface of the clavicle. It draws the shoulder down and forward. The pectoralis minor muscle arises from the third, fourth, and fifth ribs and converges to insert into the medial border of the coracoid process. It draws the scapula down and forward. The clavipectoral fascia is a strong sheet of connective tissue that splits to enclose the subclavius muscle at the clavicle. Caudad, it also splits to enclose the pectoralis minor muscle before continuing as the suspensory ligament of the axilla.

The posterior wall of the axilla is formed by the subscapularis, latissimus dorsi, and teres major muscles (Figure 1-2). The subscapularis is a wide muscle arising from the subscapular fossa on the anterior surface of the scapula. Its fibers converge and insert on the lesser tuberosity of the humerus. By rotating the arm medially, the subscapularis helps in adduction, abduction, flexion, and extension. The latissimus dorsi is a wide, thin muscle. It arises from the posterior portion of the iliac crest, the lumbar fascia, the spinous process of the lower six thoracic vertebrae, the lower ribs, and the inferior angle of the scapula. Its fibers rapidly converge to insert into the floor of the bicipital groove of the humerus. It extends, adducts, and rotates the arm medially. The teres major muscle arises from the lower posterolateral aspect of the scapula. It inserts into the medial aspect of the humerus. The muscle also adducts, extends, and rotates the arm medially.

The medial wall of the axilla is formed by the upper five ribs, their intercostal spaces, and the serratus anterior muscle (Figure 1-2). This muscle arises from the fleshy digitations on the outer surface of the upper eight ribs. Inferiorly, it interdigitates with the origin of the external oblique muscle. The muscle sweeps posteriorly around the thorax and

*See references 1, 13, 21, 22, 33, 39, 45.

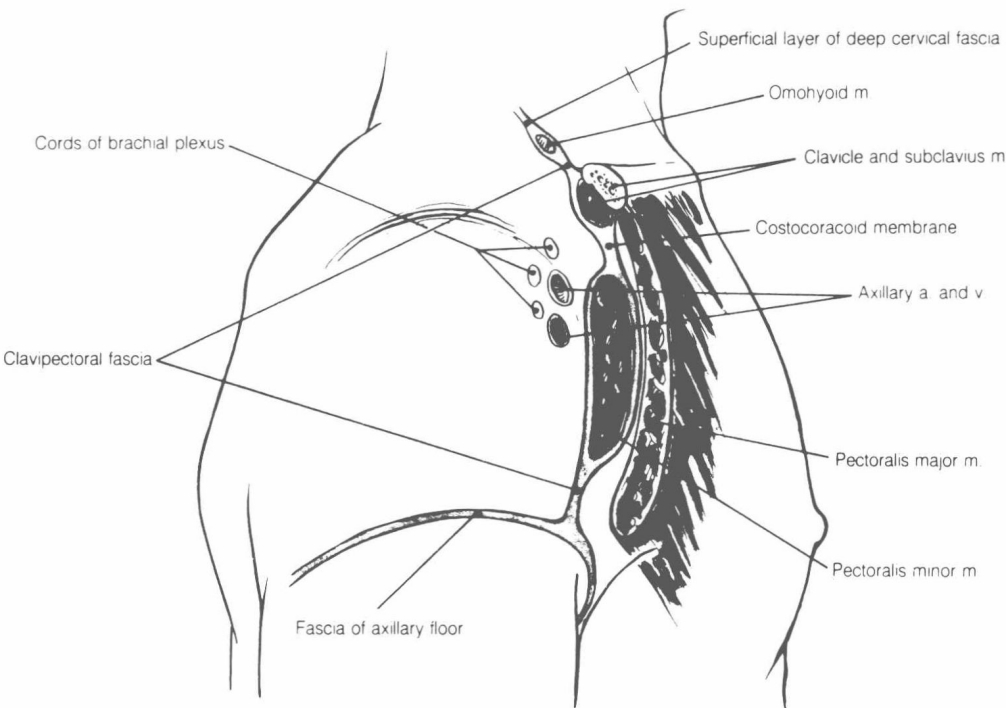


FIGURE 1-1. Clavipectoral fascia and anterior wall of the axilla.
From Hall-Craggs ECB: Anatomy as a basis for clinical medicine, Baltimore, 1985, Urban and Schwartzberg.

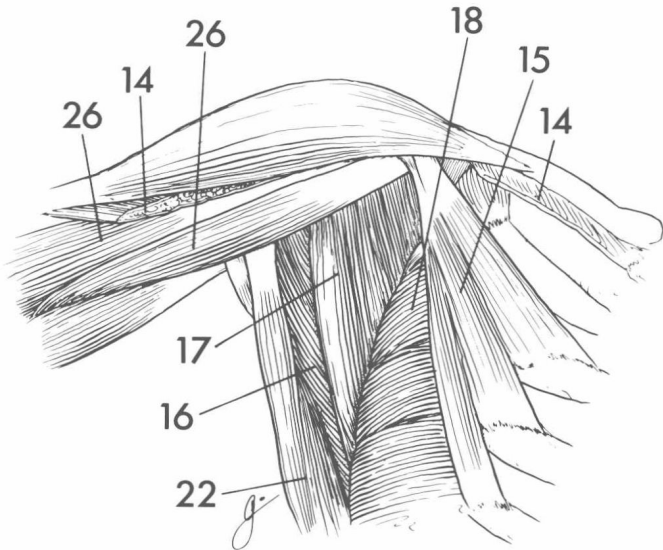


FIGURE 1-2. The axillary walls.

inserts into the anteromedial border of the scapula. It rotates and draws the scapula forward.

The lateral wall of the axilla is formed by the biceps brachii, coracobrachialis, and bicipital groove of the humerus (Figure 1-2). The biceps is a long fusiform muscle arising from two heads. The long head originates from the supraglenoid tubercle of the scapula, and the short head originates from the coracoid process. They join in the bicipital groove of the humerus and insert into the posterior radial tuberosity. The coracobrachialis arises from the tip of the coracoid process and inserts into the midmedial surface of the humerus. These muscles flex the arm.

Axillary Contents

The axilla contains the axillary blood vessels, the cords and nerves of the brachial plexus, and the axillary lymph nodes.

Brachial Plexus

The brachial plexus is formed by the anterior rami of C5 through T1 (Figure 1-3). The roots of the brachial plexus emerge in the supraclavicular fossa between the anterior and middle scalene muscles. The fifth and sixth cervical rami form the upper trunk, the seventh root forms the middle trunk, and the eighth cervical and first thoracic roots form the lower trunk of the plexus. Each trunk, which is formed in the supraclavicular fossa, then divides into anterior and posterior divisions behind the clavicle. The cords of the plexus are then formed in the axilla from the divisions. The lateral cord is formed by the anterior division of the upper and middle trunks. The posterior cord is formed by the union of the posterior divisions of the upper, middle, and lower trunks. The medial cord is formed from the anterior division of the lower trunk. Together with the subclavian artery, the plexus is enclosed in a connective tissue sheath termed the *axillary sheath*. Although the cords have a constant relationship to the axillary artery, these relationships are not reliably demonstrated by present cross-sectional imaging modalities on axial scanning.¹¹ The plexal structures can be separated from the blood vessels on sagittal and coronal magnetic resonance (MR) and computed tomography (CT) sections.^{15,32} Oblique sections paralleling the course of the brachial plexus also demonstrate the various plexal components (Figure 1-4).

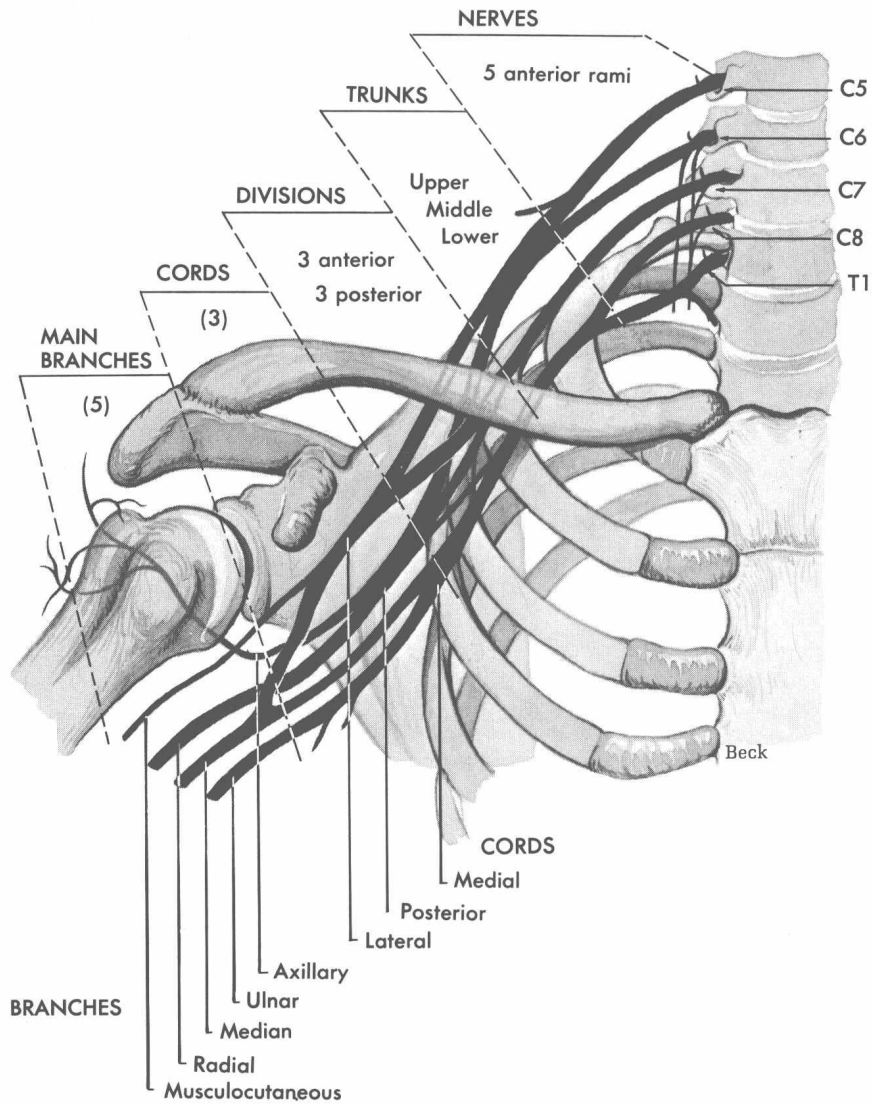


FIGURE 1-3. Brachial plexus.
From Thibodeau GA: Textbook of anatomy and physiology, St. Louis, 1987, Times Mirror/Mosby College Publishing.

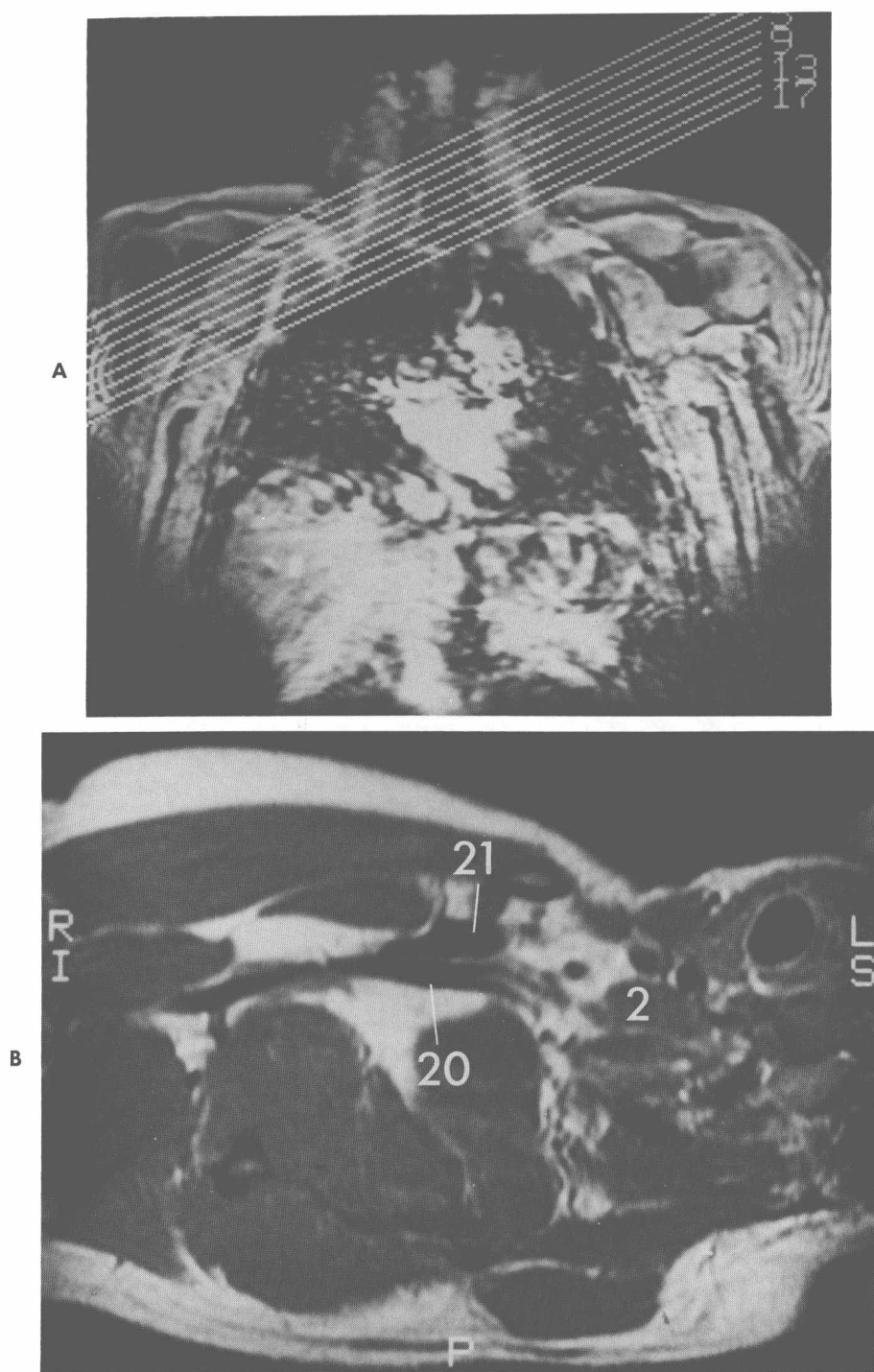


FIGURE 1-4. Axial oblique MR imaging of the supraclavicular fossa and axilla. **A**, Scout film for oblique film scans parallel course of neurovascular bundle. **B**, Scan at roof of the axilla demonstrates axillary vein (21) and artery (20) distal to their separation by anterior scalene muscle (2).

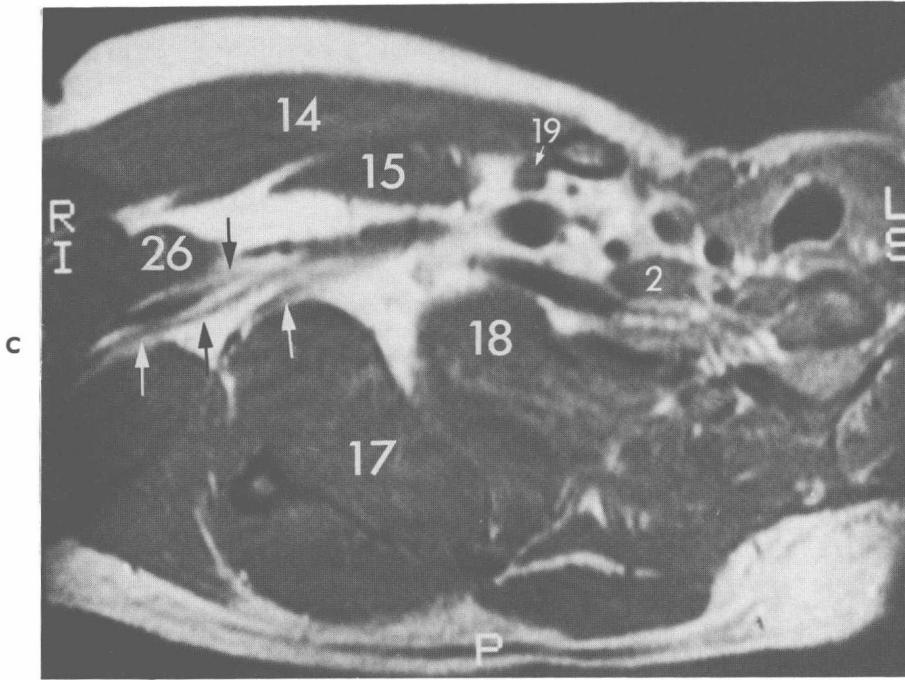


FIGURE 1-4, cont'd. C, On adjacent scan, cords of brachial plexus (*arrows*) are seen separate from vessels.

Courtesy Ashokkumar Babaria MD, Philadelphia.

The nerves arising from the brachial plexus can generally be divided into supraclavicular and infraclavicular branches. The supraclavicular branches of the roots and trunk of the brachial plexus are the dorsal scapular, long thoracic, supraclavicular, and subclavius (muscular) nerves. The infraclavicular branches of the brachial plexus cords are the pectoral, musculocutaneous, median, medial cutaneous, ulnar, subscapular, thoracodorsal, axillary, and radial nerves. Most of the infraclavicular nerves of the brachial plexus arise lateral to the pectoralis muscle. The brachial plexus cords are situated medially and behind the pectoralis muscle.

Axillary Blood Vessels

The axillary artery is the chief artery of the arm. It arises from the subclavian artery at the lateral border of the first rib and terminates at the lower border of the teres major muscle where it becomes the brachial artery (Figure 1-5). The artery courses posterior to the pectoralis minor muscle, which divides it into three parts. The first part of the axillary artery extends from the lateral border of the first rib to the upper border of the pectoralis major, where it lies behind the subclavius and pectoralis major muscles. The superior thoracic artery arises from the axillary artery. The second part of the axillary artery lies behind the pectoralis minor muscle and gives off the thoracoacromial and lateral thoracic arteries. The third portion of the artery extends from the lateral aspect of the pectoralis minor muscle to the lower border of the teres major muscle. The subscapular, anterior circumflex humeral, and posterior circumflex humeral arteries arise from it.

The axillary vein is formed at the lower border of the teres major muscle, by the confluence of the basilic vein with the venae comitantes of the brachial artery. It runs below and anterior to the axillary artery becoming the subclavian vein at the lateral aspect of the first rib. The vein receives tributaries corresponding to the axillary artery, in addition to the cephalic vein. It lies outside the axillary sheath; therefore its diameter responds to varying blood flow.

Axillary Lymphatics

The axillary lymph nodes drain the arm, breast, and thoracoabdominal wall lymphatic vessels. Although they have been anatomically divided into pectoral, subscapular, lateral, central, and apical groups, there is a simpler clinical designation. Those lymph nodes lateral to the pectoralis minor muscles are designated as level 1, beneath it they are labeled as level 2, and medial to it they are labeled as level 3.¹⁴

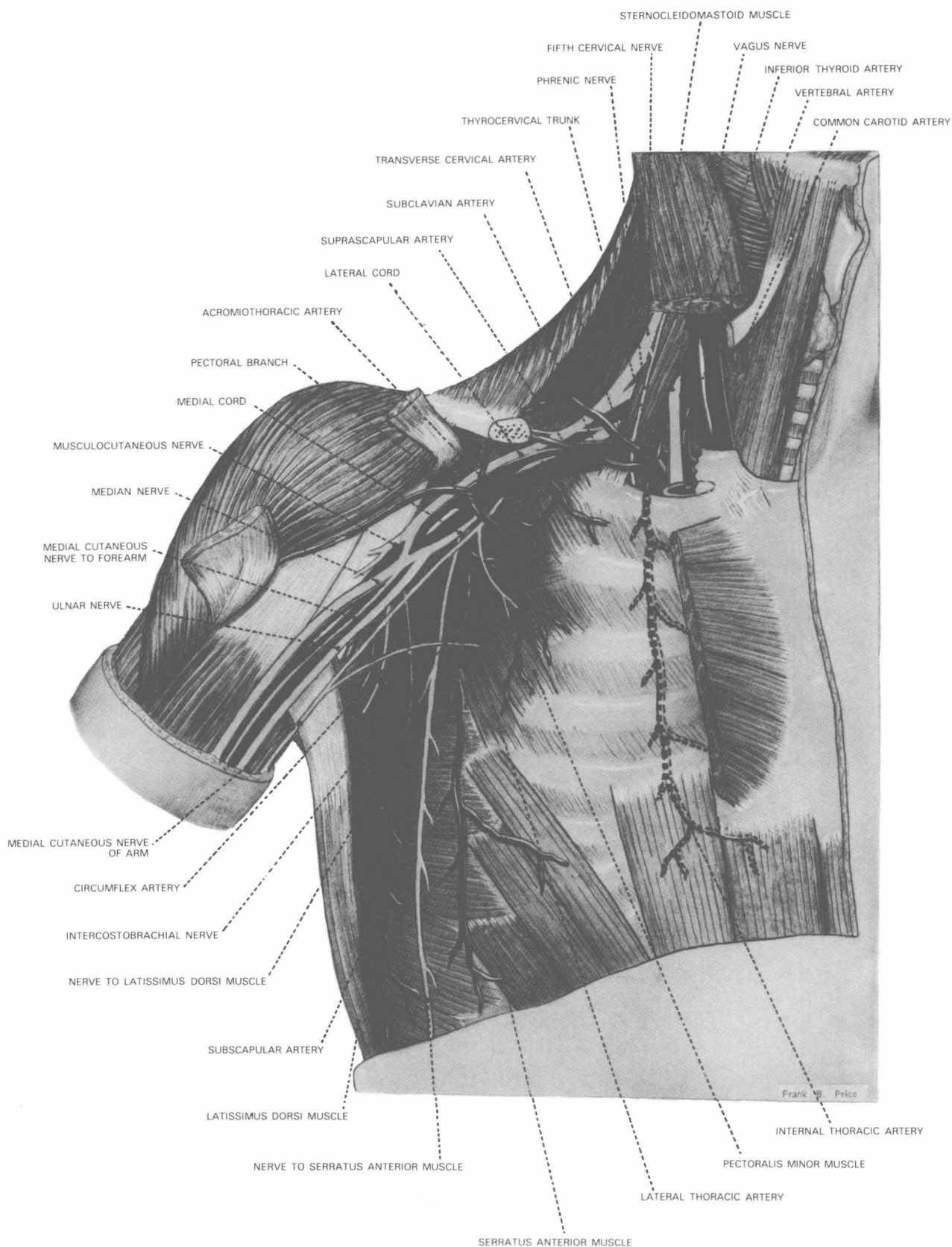


FIGURE 1-5. Subclavian and axillary arteries and their branches.

From Hamilton, WJ: Textbook of human anatomy, ed 2, St. Louis, 1976, The CV Mosby Co.