

# **Surgical Anatomy and Pathology for Orthopaedic Surgeons**

**John V. Fowles, M.B.**

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# **Surgical Anatomy and Pathology for Orthopaedic Surgeons**

**To Deirdre,**

**Because you were there during the difficult times.**

# Preface

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This book on surgical anatomy and approaches and general surgical pathology is written mainly for orthopaedic and general surgical residents in their last two years of training. Practicing surgeons may also find the notes useful as an *aide mémoire*.

The book is not a textbook and should not be used as such. The reader will get the most out of it only if he already has a good working knowledge of the subject. A list of textbooks for further reading will be found at the end of this book.

The brief, lecture note style of writing, and the pocket format, will enable the resident to revise quickly the major points of these subjects while waiting for a bus or a friend, an attribute that may be particularly useful just before exams! The line drawings are easy to reproduce on paper or blackboard and may be colored in this book to facilitate differentiation of structures. The reader may also wish to annotate the text by adding or underlining facts that he considers important.

John V. Fowles

# Acknowledgments

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This book evolved over a period of several years of teaching in Montreal and with CARE-MEDICO in Tunisia and Afghanistan. The stimulus for the book came from the medical students, residents and surgeons themselves who were enthusiastic, quick to learn, and worked hard, often under very difficult circumstances. These men and women have earned my admiration and respect, and my gratitude for all that they have taught me.

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# Contents

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Preface . . . . .	vii
Acknowledgments . . . . .	ix

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<b>PART I</b>	<b>SURGICAL ANATOMY</b>	
1	Posterior Triangle, Axilla and Brachial Plexus . . . . .	1
2	Pectoral Girdle and Shoulder . . . . .	13
3	Arm and Elbow . . . . .	24
4	Forearm, Wrist and Carpals . . . . .	48
5	Hand . . . . .	69
6	Pelvis and Hip . . . . .	83
7	Thigh and Knee . . . . .	107
8	Leg and Ankle . . . . .	133
9	Foot . . . . .	152
10	Spine and Spinal Cord . . . . .	164



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**PART II      GENERAL SURGICAL PATHOLOGY**

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11	Respiratory Physiology . . . . .	193
12	Metabolic Response to Tissue Injury . . . . .	208
13	Normal Fluid, Electrolyte and Acid-Base Metabolism . . . . .	225
14	Acute Fluid, Electrolyte and Acid-Base Imbalance . . . . .	237
15	Surgical Aspects of Body Temperature . . . . .	252
16	Surgery and Nutrition . . . . .	263
17	Inflammation and Healing . . . . .	273
18	Cardiopulmonary Arrest . . . . .	295
19	Hypovolemic Shock . . . . .	303
20	Septic Shock . . . . .	316
21	Blood Replacement, Thrombosis and Thromboembolism . . . . .	327
22	Local and Regional Anesthesia in Orthopaedic Surgery . . . . .	343
23	Postoperative Respiratory Insufficiency . . . . .	355
24	Acute Postoperative Renal Failure . . . . .	374
25	Infection and the Body's Response . . . . .	388
26	Specific Infections . . . . .	406
	Suggested Further Reading . . . . .	431
	Index . . . . .	433

# **PART 1 SURGICAL ANATOMY AND SURGICAL APPROACHES OF THE LIMBS AND SPINE**

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## **chapter 1**

# **Posterior Triangle, Axilla and Brachial Plexus**

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## **Surgical Anatomy**

### **POSTERIOR TRIANGLE OF THE NECK**

#### **Borders**

- anterior border, the posterior edge of the sternocleidomastoid (SCM) muscle,
- posterior border, the anterior edge of trapezius and the
- inferior border (base), the middle third of the clavicle.
- the apex is posterior, the base is anterior.

#### **Structures superficial to triangle**

- skin, subcutaneous fat and platysma lie over the
- adipose tissue; this is crossed by supraclavicular sensory branches of the cervical plexus (C2, C3, C4);
- external jugular vein descends vertically in front of the SCM, then goes deep to pierce the cervical fascia, crosses the anterior corner of the triangle and drains into the subclavian vein.

#### **Roof**

- formed by cervical fascia (investing layer) which envelopes the SCM and trapezius muscles and is stretched between these muscles across the triangle.

#### **Contents**

- adipose tissue and lymph glands;

- omohyoid muscle runs across the anterior corner of the triangle, deep to clavicle and SCM, and is enveloped by septum from investing layer of cervical fascia;
- accessory nerve (cranial nerve XI and C1 to C5) from beneath SCM passes down and back to trapezius and supplies both muscles;
- supraclavicular nerves before they pierce the investing fascia;
- superficial transverse cervical artery from thyrocervical trunk passes between omohyoid and scalenus anterior, then posteriorly over scapular notch to supraspinatus and infraspinatus muscles;
- external jugular vein as it drains into subclavian vein.

#### Floor

- formed from above downwards by
  - levator scapulae
  - scalenus posterior
  - scalenus medius and
  - scalenus anterior;
- all three scalenes originate from cervical vertebrae; the latter two insert into the first rib, the posterior into the second rib;
- subclavian artery—lies on first rib, between anterior and middle scalenes, then becomes the axillary artery and crosses anterior corner of triangle to pass behind clavicle and into axilla;
- subclavian vein, below and in front of artery, crosses first rib in front of scalenus anterior, so that this muscle separates the vein from the artery. This vein is a continuation of axillary vein;
- trunks of brachial plexus, above and behind the artery;
- phrenic nerve lies on anterior surface of scalenus anterior, crossing from lateral to medial as the nerve descends.
- these structures are stuck down on the muscular floor by the prevertebral fascia.

#### AXILLA

##### Boundaries

- shaped like a pyramid with four walls and a base.

##### **Anterior wall**

- two pectoral muscles and
- clavipectoral fascia.

##### **Medial wall**

- serratus anterior.

**Posterior wall, from above downwards**

- subscapularis
- teres major and
- latissimus dorsi twisting beneath teres major. In this wall is the
- quadrilateral space of Velpeau, formed by
  - subscapularis above,
  - long head of triceps medially,
  - teres major below and
  - humerus laterally. This space provides an
  - exit for axillary nerve and posterior circumflex artery from the axilla.

**Lateral wall**

- humerus and
- coracobrachialis.

**Base**

- superficial and
- deep aponeurotic layers.

**Contents****Axillary artery**

- continuation of subclavian artery, enters apex of axilla, leaves it at lower border of teres major to become brachial artery;
- divided into three parts by pectoralis minor;
- surrounded by fascia, the axillary sheath, which also surrounds the brachial plexus in the axilla.
- major branches are
  - superior thoracic artery (from first part) to pectoral muscles;
  - acromiothoracic and lateral thoracic from second part, and
  - subscapular, anterior and posterior circumflex humeral arteries from third part. For more detail, see Chapter 2, “Pectoral Girdle and Shoulder.”

**Axillary vein**

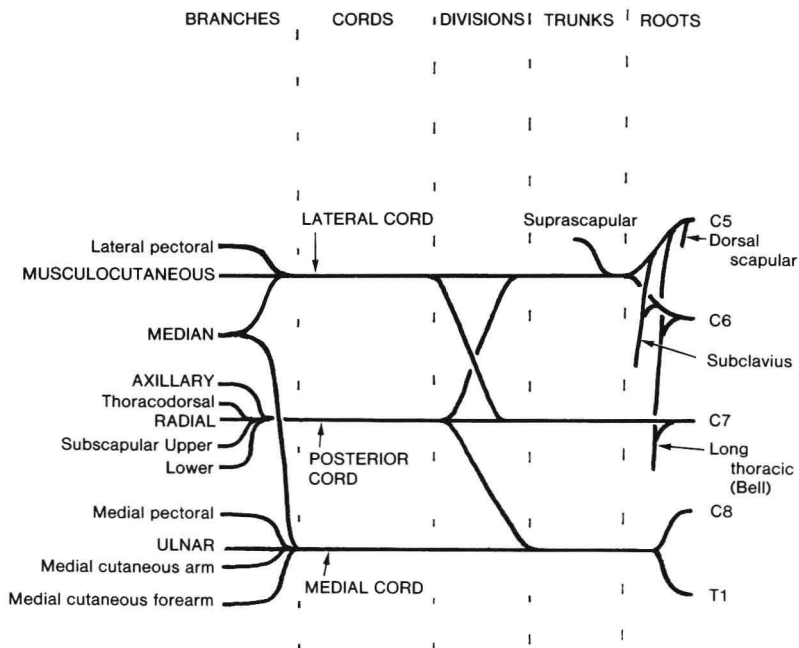
- lies medial to artery and brachial plexus and
- continues over first rib as subclavian vein.

**Brachial plexus and branches**

- see below and Figure 1.1.

**Lymph nodes**

- pectoral group lies on medial wall and drains



**Figure 1.1.** Diagram of brachial plexus.

- breast and
- upper, anterior trunk;
- scapular group on posteromedial wall of axilla, drains
  - tail of breast and
  - upper, posterior trunk;
- lateral group, medial to axillary vein, drains
  - upper limb;
- infraclavicular group, between pectoralis minor and deltoid, drains
  - upper part of breast;
- apical group, drains
  - all four groups mentioned above, and floor of axilla, and drains into
  - supraclavicular nodes in posterior triangle, thence into thoracic duct.

## BRACHIAL PLEXUS (Fig. 1.1)

## Roots

- anterior primary rami of C5, C6, C7, C8 and T1 lie between the scalenus anterior and medius muscles, beneath floor of posterior triangle.

## Trunks

- at the lateral border of scalene muscles,
  - C5 root joins C6 to form upper trunk,
  - C7 continues as middle trunk,
  - C8 joins T1 to form lower trunk.
- trunks lie in lower part of posterior triangle.

## Divisions

- behind the clavicle, each trunk divides into an
  - anterior and a
  - posterior division to supply
  - flexor and extensor muscle compartments, respectively.

## Cords

- lie in the axilla;
- lateral cord, lying lateral to axillary artery, is formed by union of anterior divisions of upper and middle trunks;
- medial cord, lying medial to axillary artery, is formed from anterior division of lower trunk;
- posterior cord, lying posterior to axillary artery, is formed from union of all three posterior divisions.
- the cords
  - approach first part of axillary artery (from lateral border of first rib to upper border of pectoralis minor),
  - surround its second part (behind pectoralis minor) and
  - give off their branches around the third part of the artery (from lower border of pectoralis minor to inferior border of teres major).

## Branches

**Branches from roots (3)***Dorsal scapular nerve (C5)*

- goes posteriorly to supply rhomboids, and small branch to levator scapulae.

*Nerve to subclavius (C5, C6)*

- travels downward and forward to supply subclavius muscle.

*Long thoracic nerve (C5, C6, C7)*

- goes posteriorly to serratus anterior.

### **Branches from trunks (1)**

- suprascapular nerve (C5, C6)
  - arises from upper trunk (Erb's point) and
  - goes posteriorly through suprascapular notch, beneath the fibrous band which bridges the notch; suprascapular artery goes over the bridge (Army over the bridge, Navy under it!). Nerve supplies supraspinatus,
  - then turns around lateral end of scapular spine to infraspinatus.

### **Branches from divisions (0)**

### **Branches from cords (13)**

#### **lateral cord (3)**

*Lateral pectoral nerve (C5, C6, C7)*

- goes anteriorly to pectoralis major

*Musculocutaneous (C5, C6, C7)*

- to coracobrachialis, biceps, brachialis and to
- skin on lateral side of forearm.

*Lateral head of median nerve (C5, C6, C7)*

#### **medial cord (5)**

*Medial pectoral nerve (C8, T1)*

- goes anteriorly to pectoralis minor and pectoralis major.

*Medial cutaneous nerve of arm (T1)*

- to skin of distal half of medial side of arm.

*Medial cutaneous nerve of forearm (C8, T1)*

*Ulnar nerve (C7, C8, T1)*

- to flexor carpi ulnaris (C7), medial half of flexor digitorum profundus (C8) and intrinsics (T1).

*Medial head of median nerve (C8, T1)*

- crosses in front of third part of axillary artery to join lateral head of median nerve.

#### **posterior cord (5)**

*Upper subscapular (C6)*

- to subscapularis.

*Thoracodorsal nerve (C6, C7, C8)*

- to latissimus dorsi.

*Lower subscapular (C6, C7)*

- to teres major and subscapularis.

*Axillary nerve (C5, C6)*

- passes back, through quadrilateral space in posterior axillary wall, then laterally and anteriorly around surgical neck of humerus to supply
  - teres minor,
  - deltoid and
  - skin over deltoid.

*Radial nerve (C5, C6, C7, C8, T1)*

- leaves axilla by passing backwards through triangular space (teres major above, long head of triceps medially and humerus laterally) to wind posterolaterally around humeral shaft;
- in the axilla, radial nerve gives
  - motor branch to long head of triceps,
  - another to medial head of triceps (this branch accompanies ulnar nerve), and a
  - cutaneous branch, the posterior cutaneous nerve of the arm (contains all T1 fibers of radial nerve);
- ultimately supplies all extensor compartment muscles of arm and forearm.

## Nerve root values of movements of upper limb

- shoulder
  - C5—abduction and external rotation
  - C6, C7, C8—adduction and internal rotation
- elbow
  - C6, C7—flexion
  - C7, C8—extension
- forearm rotation
  - C6—supination
  - C6—pronation
- wrist
  - C6, C7—dorsiflexion
  - C6, C7—palmar flexion
- fingers
  - C7, C8—extension
  - C7, C8—flexion
- hand intrinsics
  - T1 (and C8 for thenar muscles)



- learn these, and you have a working knowledge of the root innervation of all upper limb muscles!

---

## Injuries to the Plexus

- the plexus is stretched between two mobile segments, the cervical spine and the shoulder, and can be torn apart by violent injury to these segments.

### UPPER PLEXUS INJURY

- C5, C6 and sometimes C7
- called Erb's paralysis;
- caused by traction due either to
  - birth trauma (breach) or
  - two-point landing (head and shoulder) from motorcycle.
- typical deformity (policeman's tip):
  - adduction and medial rotation of humerus (deltoid and lateral rotators paralyzed, C5)
  - extension of elbow (flexors paralyzed, C5, C6),
  - pronation of forearm (supinator paralyzed, C6) and
  - slight wrist flexion (wrist extensors paralyzed, C6, C7)
- if the following muscles are paralyzed:
  - serratus anterior,
  - levator scapulae and
  - rhomboids, then the lesion must involve the roots which are probably avulsed from the cord, and recovery is very unlikely;
- careful clinical examination is essential for a precise diagnosis;
- myelography may be helpful in establishing diagnosis and prognosis because traumatic meningoceles indicate root lesions;
- injury of the trunks has better prognosis than root injuries.

### LOWER PLEXUS INJURY

- C8, T1 and sometimes C7
- Klumpke's paralysis;
- caused by traction during
  - birth injury (extended arms in breach),
  - fall onto outstretched arm or
  - arm pulled into machinery;