Chapter 2
UPPER LIMB, *MEMBRUM SUPERIUS*

SUBCLAVIAN REGION, *REGIO INFRACLAVICULARIS*

The subclavian region belongs both to the thorax and to the upper limb. Since the layers of the subclavian region take part in forming the axillary fossa, and the main neurovascular fascicle of the upper limb, the axillary fascicle, adjoins them, the topographic anatomy studies the subclavian region as a part of the **shoulder girdle**.

The surface landmarks are the clavicle, the sternum, the pectoralis major muscle, and the anterior border of the deltoid. Beneath the clavicle, between the clavicular portion of the pectoralis major and the anterior border of the deltoid, at the borderline between the outer and middle thirds of the clavicle quite often we can see the infraclavicular [Mohrenheim] fossa, *fossa infraclavicularis*. Distally it goes on as the deltopectoral sulcus, *sulcus deltopectoralis* that extends along the anterior border of the deltoid up to the lateral sulcus of the arm. Deep in this sulcus, 1.5–2 cm beneath the clavicle, it is possible to palpate the coracoid process of the scapula, *processus coracoideus*.

Limits: the superior — the clavicle; the medial — the lateral border of the sternum; the inferior — a horizontal line corresponding to the third intercostal space; the lateral — the anterior border of the deltoid.

Projections (projective lines). By the surface landmarks, it is possible to draw projections of the following structures.

From the anterior ends of the III–V ribs up to the coracoid process, the pectoralis minor projects as a small triangle (fig. 2.1). With the help of this muscle, on the skin of the subclavian region we can construct the projective lines of three triangles: the clavipectoral, pectoral and subpectoral (*trigonum clavipectorale, trigonum pectorale* and *trigonum subpectorale*). Within the limits of these triangles, they usually study the topography of the axillary neurovascular fascicle: *a., v. axillaris, plexus brachialis* and its branches (in detail see the section «Axillary region»).

The projection of the neurovascular fascicle in this region is constructed from the medial half of the middle third of the clavicle downwards and outwards as low as the limit between the lower and middle thirds of the deltopectoral sulcus. The projection of *v. subclavia* takes the most medial part of the fascicle. Along the *sulcus deltopectoralis*, *v. cephalica* is projected.

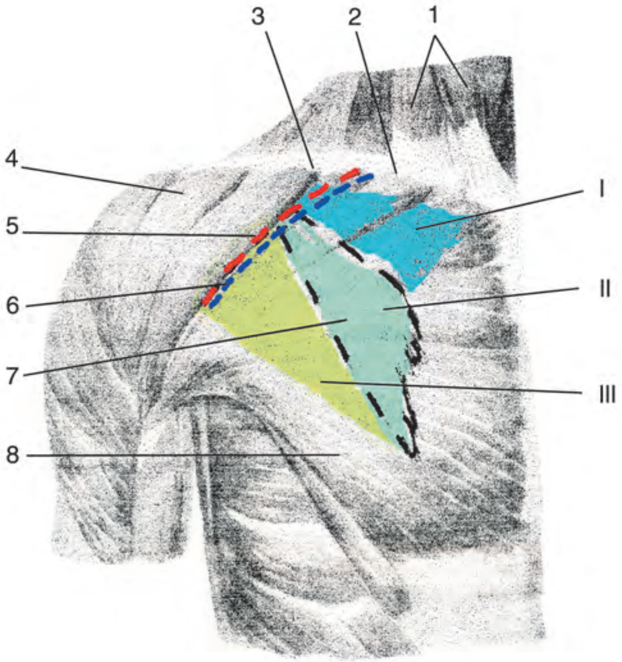

Fig. 2.1. The triangles of the subclavian region and the projection of *a. et v. axillares*: I — ***trigonum clavipectorale***; II — ***trigonum pectorale***; III — ***trigonum subpectorale***: *1 — m. sternocleidomastoideus; 2 — clavicula; 3 — sulcus deltopectoralis; 4 — m. deltoideus; 5 —* the *a. axillaris* projection*; 6 —* the *v. axillaris* projection*; 7 —* the *m. pectoralis minor* contour*; 8 — m. pectoralis major*

Layers

The skin is thin, moderately movable.

The subcutaneous adipose tissue has no special qualities, and varies individually. From the cervical plexus, supraclavicar nerves pass through this tissue.

The superficial fascia in the upper third of the region forms a capsule for *platysma* (the subcutaneous muscle of the neck), which takes origin from the *fascia pectoralis*. At the level of the II–III ribs, it thickens and forms the suspensory ligaments of the mammary gland, *ligg. suspensoria mammaria* [Cooper]. At all the limits of the subclavian region, the superficial fascia passes on into the adjacent regions.

The proper fascia of the region, *fascia pectoralis*, surrounds the **pectoralis major** from front and posteriorly with the superficial and deep laminae. Between them, dividing the fibers of the pectoralis major, lie numerous fascial bridles.

> ***As a result, pyo-inflammatory process in the muscle develops from surface into depth. Along the bridles also go lymphatic vessels; this explains spreading of metastases, in cases of mammary gland cancer, into the deep surface of the pectoralis major.***

The superficial lamina and the deep one of the *fascia pectoralis* superiorly attach to the fascia of the subclavian muscle and also to the superficial lamina of the proper fas-

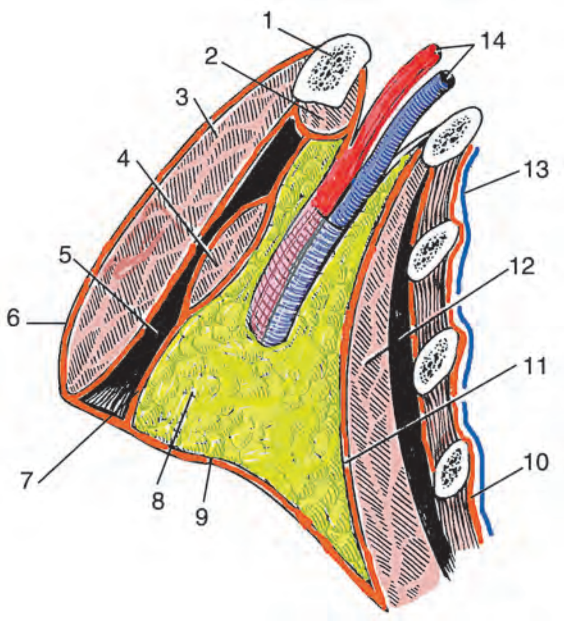

Fig. 2.2. The layers of the subclavian region: *1 — clavicula; 2 — m. subclavius; 3 — m. pectoralis major; 4 — m. pectoralis minor; 5 — spatium subpectorale; 6 — fascia pectoralis; 7 — fascia clavipectoralis; 8 —* the cellular tissue of the axillary fossa; *9 — fascia axillaris; 10 — fascia endothoracica; 11 — fascia thoracica; 12 — m. serratus anterior; 13 — pleura parietalis; 14 — a. et v. axillares*

cia of the neck (the 2nd fascia by Shevkunenko). They unite below, on the lateral border of the pectoralis major, forming thus a closed capsule for it. Behind the clavicle, the part of the 5th fascia of the neck (prevertebral), which covers the anterior scalene muscle, attaches to the first rib.

The following layer (fig. 2.2) is the **cellular tissue of the subpectoral space, *spatium subpectorale*** (in detail its walls will be described below).

The clavipectoral fascia, *fascia clavipectoralis*, is situated even deeper. Superiorly, it begins from the clavicle and the coracoid process of the scapula, from the medial side — at the beginning of the pectoralis minor (at the level of the III–V ribs), inferiorly and laterally, it attaches to the deep lamina of the fascia at the lateral border of the *pectoralis major*. Thickened fascicles of the clavipectoral fascia in this place form a ligament which attaches to the axillary fascia, *fascia axillaris* (fig. 2.3).

These fascicles are called the suspensory ligament, *lig. suspensorium axillae* [Gerdy].

Near the clavicle, the fascia also is thickened; here the subclavian vein adjoins it. By abducting the arm abruptly, the vein may be squeezed between the fascia, clavicle and rib that may cause an acute thrombosis of the vein.

Fascia clavipectoralis forms a capsule for the pectoralis minor and for the subclavius muscles.

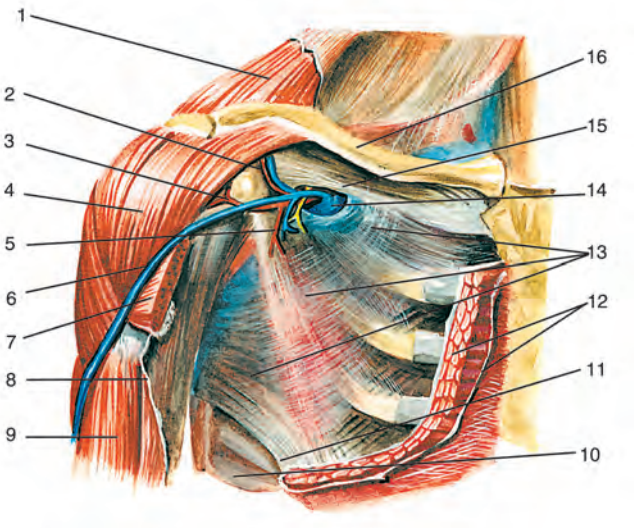

Fig. 2.3. The clavipectoral fascia. *M. pectoralis major* is removed: *1 — m. trapezius; 2 — ramus acromialis a. thoracoacromialis; 3 — ramus deltoideus a. thoracoacromialis; 4 — m. deltoideus; 5 — ramus pectoralis a. thoracoacromialis; 6 — v. cephalica; 7 — m. pectoralis major; 8 — fascia brachii; 9 — m. biceps brachii (caput longum); 10 — fascia thoracica; 11 — fascia axillaris et lig. suspensorium axillae; 12 — m. pectoralis major, fascia pectoralis; 13 — fascia clavipectoralis; 14 — v. axillaris; 15 — lig. costocoracoideum; 16 — clavicula*

Thus, **the subpectoral cellular space** lies between the pectoralis major and minor muscles with their fascial covers.

The anterior wall of the space is the deep lamina of the fascia of the pectoralis major.

The posterior — the clavipectoral fascia covering the pectoralis minor.

Superiorly, the space is enclosed at the clavicle where both fasciae unite.

Medially, it is enclosed at the place where both muscles take their origin from the ribs.

Laterally and inferiorly, the space is enclosed by the union of the fascia of the pectoralis major and the clavipectoral fascia along the lateral border of the pectoralis major.

The following layer is the **cellular tissue of the upper part of the axillary fossa,** in which passes the main neurovascular fascicle: the axillary vessels and fascicles of the brachial plexus first, and then their branches (sometimes this layer is called **the deep subpectoral space**).

Behind this cellular tissue, the proper fascia, *fascia thoracica* lies covering the serratus anterior and the intercostal spaces (see fig. 2.2).

The superior limit of the region is the clavicle. It is situated under the skin and subcutaneous cellular tissue and is easily palpated. To the inferior border of the clavicle, the pectoral and the clavipectoral fasciae are fixed.

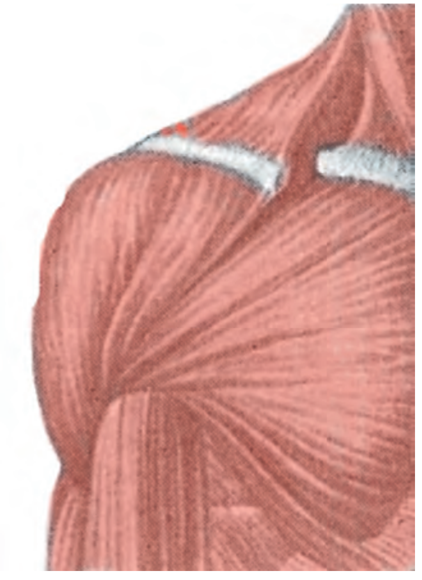

Fig. 2.4. Separation of the clavicle fragments [loose fracture]

The clavicle is most frequently fractured by falls onto the arm or forearm. The weakest part of the clavicle is located at the border between its lateral and middle thirds. After fracture of clavicle, its middle part is elevated due to constriction of m. sternocleidomastoideus while the lateral part is depressed due to the weight of the upper limb (fig. 2.4).

In newborn infants, clavicle fractures are quite frequent during their passing through the parturient canal. Such fractures usually heal without any intervention. In children of pre-school and school age, clavicle fractures happen more often than in adults. At such age they are incomplete in many cases, when one side of the bone is broken and the other is bent. It resembles a broken branch of a tree (green-stick); this is why there exists a term «a green-stick fracture».

The fragments of the fractured bone separating up and down can injure the neurovascular fascicle that lies behind the clavicle, so the primary treatment of the fracture is to immobilize the shoulder girdle by putting a 8-shaped bandage, sometimes by things at hand (e.g., some clothes).

Topography of neurovascular fascicle

In the **subclavian region**, we study the topography of that part of the axillary fascicle, which lies within the limits of the clavipectoral triangle (between the clavicle and the superior border of the pectoralis minor).

In this triangle right under the clavipectoral fascia lies the **axillary vein**, *v. axillaris*, coming from under the superior border of the pectoralis minor and going in oblique direction from bottom upwards to the point, located 2.5 cm inwards from the middle of the clavicle. In the area between the first rib and the clavicle, this vein is already called the **subclavian**. The fascial sheath of this vein closely adjoins the fascia of the subclavian muscle and the periosteum of the first rib. It prevents the walls of the vein from moving closer to each other.

This is why there comes air embolism hazard when the vein is injured. At the same time, a good fixation of the vein allows to puncture it at this place.

The axillary artery, *a. axillaris*, lies laterally and deeper to the vein. In the clavipectoral triangle, from the axillary artery branches *a. thoracica superior* splitting in the first and second intercostal spaces, and *a. thoracoacromialis* that almost at once splits into three branches: deltoid, pectoral and acromial. All of them perforate the clavipectoral fascia and run to the respective muscles. In the same place, *v. cephalica* passes through the fascia from the deltopectoral sulcus into the axillary fossa and runs into the axillary vein (see fig. 2.3).

The fascicles of the brachial plexus are located more lateral and deeper to the artery.

Thus, both in the direction from front to backwards and from the medial part to the lateral one, the elements of the neurovascular fascicle are located identically: first the vein, then the artery, then the brachial plexus.

At abrupt moving the head sideways (e.g. at falls) an injury of the superior trunk of the brachial plexus can occur, resulting in the so-called Duchenne-Erb paralysis. Since in the superior trunk go the nerve fibers taking part in forming n. axillaris, n. musculocutaneus and partially n. radialis, the function of muscles innervated by these nerves will be lost. This is why it will be impossible to abduct the arm (m. deltoideus is innervated by n. axillaris), to bend the forearm (m. biceps brachii, m. brachialis are innervated by n. musculocutaneus), and the arm will sag as a pea vine.

At the medial border of the axillary vein, the apical group of **lymph nodes** of the axillary fossa is situated.

Relation between cellular tissue of subclavian region and adjacent ones

- Alongside the branches of *a. thoracoacromialis*, it is connected with the cellular tissue of the axillary fossa through the defect in the posterior wall (the *f. clavipectoralis*) of the subpectoral space.
- Alongside the cellular tissue, going along with the main neurovascular fascicle, the pyo-inflammatory process can spread to the lateral triangle of the neck.
- Along the same fascicle, the cellular tissue is connected with the areas of the axillary fossa, lying below.

AXILLARY REGION, *REGIO AXILLARIS*, AND AXILLARY FOSSA, *FOSSA AXILLARIS*

Surface landmarks: contours of *mm. pectoralis major, latissimus dorsi et coracobrachialis*. When the arm is abducted, the region has the form of a fossa, *fossa axillaris*.

Limits of the region (on the surface of the body! Not to confuse with the walls of the axillary fossa, about the latter it will be told below): the anterior limit is the lower border of *m. pectoralis major;* the posterior — the lower border of *m. latissimus dorsi;* the medial — the line joining the borders of these muscles on the thoracic wall along the III rib; the lateral — the line joining the borders of the same muscles on the medial surface of arm.

The projection of the axillary neurovascular fascicle (*a. et v. axillaris,* fascicles of *plexus brachialis* and nerves, branching off from them) is a line, drawn from a point between the anterior and middle thirds of the lateral limit of the region (the medial surface of the arm) up to the point 1 cm inwards from the middle of the clavicle (fig. 2.5).

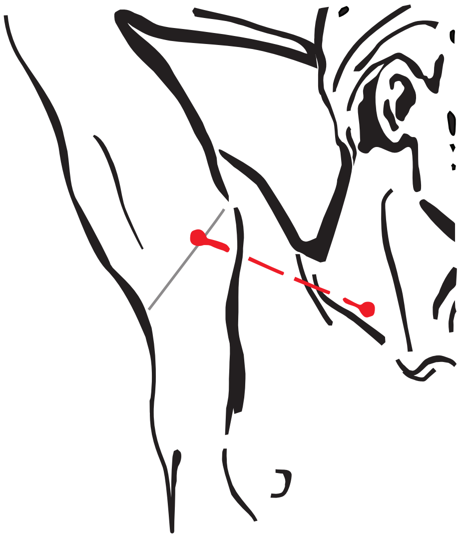

Fig. 2.5. The projection of the axillary artery

Layers

The skin is thin and covered by hairs within the borders of the region, it contains a large number of sweat, sebaceous and apocrine glands, the inflammation of which may result in furuncles and hidradenitis. The subcutaneous adipose tissue is poor and is located in layers between the thin laminae of the superficial fascia. In the subcutaneous cellular tissue lie cutaneous branches of nerves of the arm and superficial lymph nodes. The outflow from them is carried into the deep lymph nodes along the efferent lymphatic vessels perforating the proper fascia.

The superficial fascia is feeble.

The proper fascia, *fascia axillaris*, is thin in the centre of the region; narrow interstices can be seen in it, through which thin circulatory and lymphatic vessels and nerves pass to the skin. At the borders of the region, the axillary fascia is more thick and goes on frontally as the pectoral fascia, *fascia pectoralis*, posteriorly — as the thoracolumbar fascia, *fascia thoracolumbalis*, laterally — as the brachial fascia, *fascia brachii*, and medially — as the proper thoracic fascia, *fascia thoracica*, covering the serratus anterior. The ligament suspending the axillary fascia, *lig. suspensorium axillae* [Gerdy] — a derivative from the *fascia clavipectoralis*, studied in the section about the subclavian region — attaches to the deep surface of the axillary fascia along the border of *m. pectoralis major*. The ligament pulls the proper fascia upwards, and due to this, the axillary region has the form of a fossa.

Subfascial structures

The **cellular space** of the axillary fossa is located under the *fascia axillaris*. Here lies adipose tissue of considerable amount, the neurovascular fascicle and some groups of lymph nodes.

As any cellular space, the axillary one is limited by a number of fasciae and muscles, lying under them. Its form is a tetrahedral pyramid, which base is the *fascia axillaris*, and the apex lies by the middle of the clavicle, between it and the first rib. Four faces of the pyramid (**these are walls of the axillary fossa, they should not be confused with the limits!**) are formed the following way:

- **the anterior** — by the *f. clavipectoralis* with the pectoralis minor within it;
- **the medial** one — by the *f. thoracica* covering the thoracic wall and the serratus anterior;
- **the lateral** — by the *f. brachii* covering the *m. coracobrachialis* and the short head of the *m. biceps brachii* up to the place of their attachment to the coracoid process;
- **the posterior** — by the *f. m. subscapularis* and by the broad flat tendon of *m. latissimus dorsi*.

The anterior wall as a whole also contains the pectoralis major. As it was already mentioned, in the clavipectoral fascia, there is a foramen transmitting the branches of *a. thoracoacromialis* and *v. cephalica*.

Along the medial wall upon the dents of *m. serratus anterior* [Boxer], *a. thoracica lateralis* (from *a. axillaris*) goes from above downwards, and a little backwards from it — *n. thoracicus longus* [Bell] (from the supraclavicular part of the brachial plexus).

In the lower third of the lateral wall, lengthways to the *m. coracobrachialis*, the axillary neurovascular fascicle passes. Its fascial sheath attaches here to the fascial sheath of the muscle. It is considered that at the medial border of the *m. coracobrachialis* (a surface landmark) it is possible to press the axillary artery to the humerus. However, this muscle can be quite easily found only in thin people with well-developed physique. That is why temporal hemostasis is usually made by pressing the artery with a finger, using a projective line.

The posterior wall of the axillary fossa consists of the tendon of the latissimus dorsi and the subscapularis, closely adjoining it superiorly. On the anterior surface of the *m. subscapularis,* the *nn. subscapularis et thoracodorsalis* pass in the oblique direction.

The tendon of the latissimus dorsi is always well identified and serves as an important **internal landmark**. With its help, it is easy to find two foramina in the posterior wall of the axillary fossa: quadrilateral and trilateral. These foramina connect the axillary fossa with the deltoid and scapular regions. From the scapular region aspect, they were described above. From the axillary fossa aspect, they have other boundaries (fig. 2.6).

The boundaries of the quadrilateral foramen are the following: the lower is the superior border of the tendon of *m. latissimus dorsi*, the upper — the inferior border of *m. subscapularis*, the lateral — the surgical neck of the humerus, the medial — the tendon of the long head of *m. triceps brachii* lying deeper.

The boundaries of the trilateral foramen: the lower — *m. teres major*, partially or entirely coated by the superior border of the tendon of *m. latissimus dorsi*; the upper — the inferior border of *m. subscapularis*, and the lateral — the tendon of the long head of *m. triceps brachii*.

As it is shown in the figure, the same muscles form the upper and lower boundaries of both foramina: the *m. subscapularis* and *m. latissimus dorsi* with *m. teres major*. The quadrilateral foramen lies lateral, closer to the humerus, and the trilateral one is medial. To find the foramina, it is enough to look for the angle between the humerus and the upper border of the tendon of *m. latissimus dorsi*. The angle is already a part of the quadrilateral foramen. By moving an instrument upwards, it is possible to identify at once the subscapularis muscle, and by moving inwards and into the depth of this foramen, it is easy to reach the tendon of the long head of the triceps brachii. Moving on to the medial side, above this tendon in the space between the tendon of the latissimus dorsi and subscapularis, it is easy to find the trilateral foramen.

Through the quadrilateral foramen the axillary nerve, n. *axillaris* and the posterior circumflex humeral artery, *a. circumflexa humeri posterior* pass from the axillary fossa

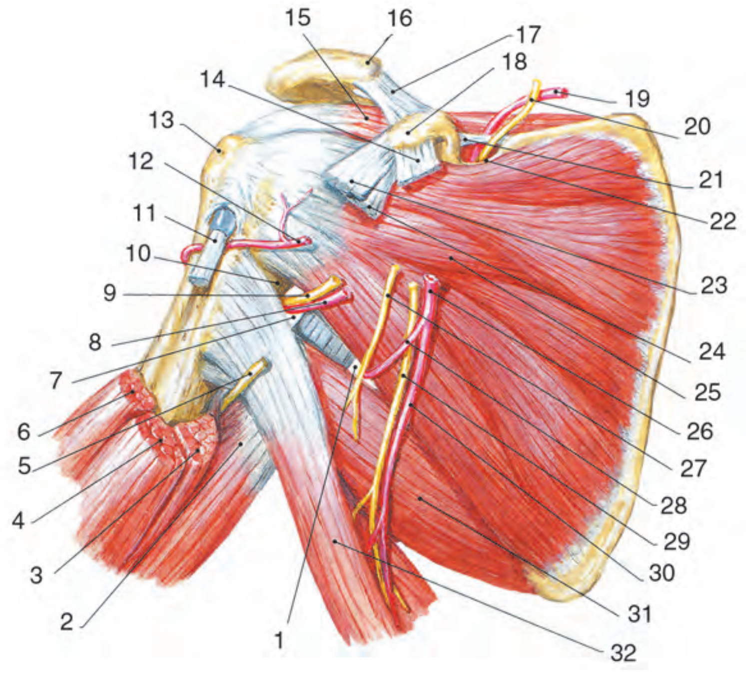

Fig. 2.6. The posterior wall of the axillary fossa. The quadrilateral and trilateral foramina. The axillary artery and bundles of the brachial plexus are removed. *M. latissimus dorsi* is pulled down: *1 — **foramen trilaterum**; 2 — caput longum m. tricipitis brachii; 3 — m. coracobrachialis; 4 — caput breve m. bicipitis brachii; 5 — n. radialis; 6 — caput longum m. bicipitis brachii; 7 — **foramen quadrilaterum**; 8 — a. circumflexa humeri posterior; 9 — n. axillaris; 10 — collum chirurgicum humeri; 11 — tendo m. bicipitis brachii (caput longum); 12 — a. circumflexa humeri anterior; 13 — tuberculum majus; 14 — tendo m. pectoralis minor; 15 — tendo m. supraspinatus; 16 — acromion; 17 — lig. coracoacromialis; 18 — processus coracoideus; 19 — a. suprascapularis; 20 — n. suprascapularis; 21 — lig. transversum scapulae superius; 22 — incisura scapulae; 23 — tendo m. bicipitis brachii (caput breve); 24 — tendo m. coracobrachialis; 25 — m. subscapularis; 26 — a. subscapularis; 27 — n. subscapularis; 28 — a. circumflexa scapulae; 29 — n. thoracodorsalis; 30 — a. thoracodorsalis; 31 — m. teres major; 32 — m. latissimus dorsi* (pulled down)

into the deltoid region. Through the trilateral foramen, the circumflex scapular artery, *a. circumflexa scapulae* passes into the scapular region.

Near the posterior wall, there is a series of other important neurovascular structures; their topography will be explained below.

Topography of neurovascular structures

The *a. axillaris* as a continuation of *a. subclavia* right below the clavicle is the main vessel of the upper limb (fig. 2.7).

Its topography is studied usually in triangles formed in relation to the *m. pectoralis minor*: *tr. clavipectorale, tr. pectorale,* and *tr. subpectorale* (they were mentioned in the section about the topography of the subclavian region). In the first of them, from the axillary artery the *a. thoracica superior* and *a. thoracoacromialis* branch off; in the

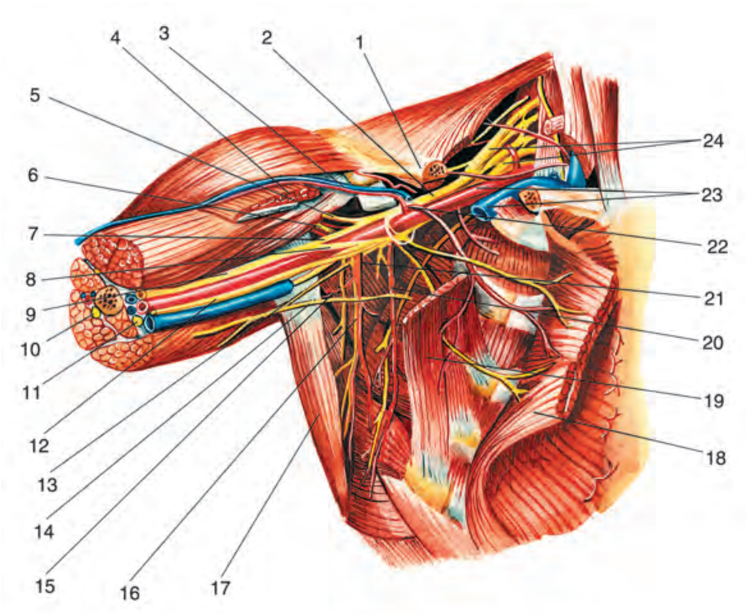

Fig. 2.7. Vessels and nerves of the axillary region: *1 — clavicula et m. subclavius; 2 — fasciculus lateralis; 3 — v. cephalica; 4 — m. pectoralis major; 5 — n. musculocutaneus; 6 — n. axillaris et a. circumflexa humeri posterior; 7 — radix lateralis n. mediani; 8 — radix medialis n. mediani; 9 — n. medianus; 10 — n. radialis; 11 — n. ulnaris; 12 — n. cutaneus antebrachii medialis; 13 — n. cutaneus brachii medialis; 14 — n. intercostobrachialis; 15 — a. circumflexa scapulae; 16 — a., n. thoracodorsalis; 17 — m. latissimus dorsi; 18 — m. pectoralis major; 19 — m. pectoralis minor; 20 — a. thoracica lateralis; 21 — a. subscapularis; 22 — a. thoracoacromialis; 23 — a., v. axillares; 24 — plexus brachialis*

second one — *a. thoracica lateralis*, and in the third, subpectoral triangle, from *a. axillaris — a. subscapularis, aa. circumflexae humeri anterior et posterior* branch off.

The topography of elements of the neurovascular fascicle in **trigonum clavipectorale** has been studied in the section about the subclavian region.

In the **pectoral triangle**, medially (nearer to the surface) from the artery, there is the axillary vein and lymph nodes, going along it. Three fascicles of the brachial plexus — the medial, lateral and posterior — lie near to *a. axillaris* respectively to their names: the medial one — medially from the artery, the lateral — laterally, the posterior — behind the artery. The *a. thoracica lateralis* runs to the medial wall of the axillary fossa, where branches of the artery run to muscles and to the mammary gland.

In the **subpectoral triangle**, the topography of vessels and nerves is the most complex. Here, fascicles of the brachial plexus break into several large nerves, each of which takes a certain place relative to the axillary artery. It is useful to recall that the medial fascicle of the brachial plexus gives off the medial brachial cutaneous nerve, *n. cutaneus brachii medialis*, the medial antebrachial cutaneous nerve, *n. cutaneus antebrachii medialis*, the ulnar nerve, *n. ulnaris*, and the medial root of the median nerve, *n. medianus*. The lateral root of the median nerve and the musculocutaneous nerve, *n. musculocutaneus* [Casserio] branch off from the lateral fascicle, and from the posterior one go the radial nerve, *n. radialis*, and the axillary nerve, *n. axillaris*.

The most superficial structure is *v. axillaris* that in relation to the artery and nerves on its whole extent lies anteriorly and medially.

The *n. medianus* is located to the front from the artery. It is easy to find by the place of junction of its two roots — medial and lateral (**an internal landmark**), in the form of the letter Y. Between the roots, the trunk of the axillary artery is well seen.

The nerves from the medial fascicle of the brachial plexus are situated medial from the artery. The largest among them is the *n. ulnaris.* Medially from the artery, also go the *n. cutaneus antebrachii medialis* and *n. cutaneus brachii medialis*.

The lateral root of the median nerve and the musculocutaneous nerve go laterally from the artery, the latter directing to the *m. coracobrachialis* and perforating it.

Behind the artery, the radial and axillary nerves are located (both out of the posterior fascicle). The *n. radialis*, the largest of branches of the brachial plexus, lies behind the artery on the whole length of the subpectoral triangle and together with the artery adjoins the tendon of the latissimus dorsi, passing into the anterior region of the arm. Into the same region, the *n. medianus*, *nn. cutanei brachii et antebrachii mediales* and *n. ulnaris* also come.

The *n. axillaris* at first lies posterior and slightly lateral to the artery on the posterior wall of the axillary fossa; then it goes obliquely and laterally in the direction of the quadrilateral foramen at the superior border of the *m. latissimus dorsi*. To the same foramen also run the posterior circumflex humeral artery, *a. circumflexa humeri posterior* and the veins that accompany it and together with the *n. axillaris* form the neurovascular fascicle adjoining the surgical neck of the humerus posteriorly. The fascicle goes then into the subdeltoid space. Here, deeper to the nerve, under a thin layer of friable cellular tissue lies the lower part of the capsule for shoulder joint, *recessus axillaris*.

If the axillary artery is drawn aside, it is possible to see *a. subscapularis* coming from its posterior wall. The place of its branching off is about 1 cm from the superior border of the tendon of *m. latissimus dorsi*. The *a. subscapularis*, the largest of the branches of the axillary artery, directs downwards and almost at once splits into the circumflex scapular artery, *a. circumflexa scapulae* and the thoracodorsal artery, *a. thoracodorsalis*. The first of them passes into the trilateral foramen and proceeds to lateral border of the scapula. The second one is a continuation of the subscapular artery; it runs downwards with the subscapular nerve and at the angle of the scapula breaks into terminal branches.

The *aa. circumflexae humeri anterior et posterior* arise 0.5–1.0 cm distal to *a. subscapularis*. The *a. circumflexa humeri anterior* traces laterally under *m. coracobrachialis* and *caput breve m. bicipitis brachii* and adjoins the surgical neck of humerus anteriorly. Both circumflex humeral arteries supply the shoulder joint and the deltoid with blood, where they anastomose with the deltoid branch of *a. thoracoacromialis*.

The *a. axillaris* is the main vessel of the upper limb. Its branches in the region of the shoulder girdle form anastomoses with the arteries out of the systems of the subclavian and brachial arteries that are the collateral ways of blood supply of the upper limb in case the *a. axillaris* is injured or ligated. The more reliable collateral blood supply develops when the axillary artery is in ligation or is occluded above (proximal of) the branching of *a. subscapularis* and both circumflex arteries of the humerus. (More details will be given below, in the section about collateral blood circulation in the regions of shoulder girdle).

The **lymph nodes** of the axillary fossa form 5 groups that are easier to remember in their relation to the walls. One of them — the central — is situated in the base of a pyramid formed by the walls. Three others go along the sides of the pyramid, except for the medial one. They are the posterior, lateral and anterior nodes respectively. The fifth group is at the apex of the pyramid and thus is called apical.

1. *Nodi lymphoidei centrales* are the largest nodes. They lie in the centre of the base of the axillary fossa under the proper fascia along the axillary vein.
2. *Nodi lymphoidei subscapulares (posteriores)* lie alongside with subscapular vessels and receive lymph from the upper part of the back and the posterior surface of the neck.
3. *Nodi lymphoidei humerales (laterales)* lie by the lateral wall of the axillary fossa, more medial than the neurovascular fascicle, and receive lymph from the upper limb.
4. *Nodi lymphoidei pectorales (anteriores)* are on the serratus anterior muscle alongside with *a. thoracica lateralis*. They receive lymph from the anterolateral surface of the thorax and the abdomen (above the umbilicus), and also from the mammary gland. One (or several) of the nodes of this group lies at the level of the third rib under the border of the *m. pectoralis major* and is singled out as a node of Sorgius. These nodes are frequently the first to be affected by metastases of mammary gland cancer.
5. *Nodi lymphoidei apicales* lie in *trigonum clavipectorale* lengthways the *v. axillaris* and receive lymph from lymph nodes lying beneath, and from the superior pole of mammary gland.

Further, the lymphatic vessels pass into the lateral triangle of the neck alongside with the axillary neurovascular fascicle and take part in forming the subclavian lymph trunk, *truncus subclavius.*

The main groups of lymph nodes of the axillary fossa are palpated in a position of an adducted arm; such position is required to relax the axillary fascia, under which they are located. Only the lymph node of Sorgius is palpated differently. The arm of a patient is placed over the doctor's shoulder, and he palpates the lymph node in the place where the lower border of the pectoralis major attaches the thoracic cage.

Connection of cellular tissue of axillary fossa with adjacent regions

- Alongside the neurovascular fascicle in a proximal direction it is connected with the cellular tissue of the neck, and from there — with the cellular tissue of the anterior mediastinum.
- In the distal direction alongside the neurovascular fascicle, it is connected with the cellular tissue of the arm.
- Through the trilateral foramen — with the posterior surface of the scapular region.

- Through the quadrilateral foramen — with the subdeltoid space.
- Through the clavipectoral fascia, alongside with *a. thoracoacromialis*, — with the subpectoral space.
- Between the deep (anterior) surface of scapula and the wall of the thoracic cage — with the subscapular space.

SCAPULAR REGION, *REGIO SCAPULARIS*

Surface landmarks. The superior border of the scapula is located at the level of the II rib (the medial angle reaches the level of the first rib); the inferior angle is at the level of the VIII rib. The spine of the scapula corresponds approximately to the level of the III rib.

The most accessible for palpation and, hence, the most reliable surface landmarks of the region are the medial border of the scapula, its inferior angle, the spine of the scapula and the acromion. The line connecting the lateral part of the acromion and the inferior angle of the scapula corresponds to the lateral border of the scapula, which frequently cannot be palpated because of muscles covering it.

Limits. The superior is the line drawn from the acromioclavicular articulation perpendicular to the vertebral column; the inferior — a horizontal line going through the inferior angle of scapula; the medial — along the medial border of the scapula up and down to the cross with the superior and inferior limits; the lateral limit — from the lateral end of the acromion vertically down to the inferior limit of the region.

Projections of the main neurovascular structures of the region. The *a. et n. suprascapularis* are projected on the line going from the middle of the clavicle to the point, corresponding to the base of the acromion, i.e. the limit between the lateral and middle thirds of the spine of scapula. The projective line of the *r. profundus a. transversae colli* goes along the medial border of scapula 0.5–1 cm inwards from it. The place where *a. circumflexa scapulae* enters the infraspinous compartment is projected upon the middle of the projection of the lateral border of scapula.

Layers

The skin is thick, and slightly movable; it is difficult to take it in a fold. Sometimes in men, the skin is covered with hairs.

When the skin is dirty, in places of clothes friction, in aged and exhausted people, in people with diabetes mellitus, furuncles (the furunculosis) can appear in this region. There are many sebaceous glands in the skin; when they are occluded in this region, there can frequently occur cysts of sebaceous glands — atheromas, requiring surgical removal.

The subcutaneous adipose tissue has one layer; it is dense and cellular because of connective septa, which go from skin into depth, to the proper fascia.

The superficial fascia can consist of several laminae of different density. Suprafascial structures are hardly present, thin subcutaneous nerves are branches of the axillary nerve and supraclavicular ones.

The proper fascia of superficial muscles of the region (*m. trapezius, m. deltoideus, m. latissimus dorsi*) forms capsules for them.

The fascia supraspinata et fascia infraspinata are the proper fasciae of the deep muscles of scapula taking their origin from its posterior surface. These fasciae are dense and have an aponeurotic structure. As a result of their attachment to the borders of scapula and spine, here are formed two osteofibrous compartments: the supraspinous and infraspinous.

Topography of supra- and infraspinous compartments of scapula

The supraspinous compartment corresponds to the *fossa supraspinata* of the scapula. Superiorly, it is enclosed due to the attachment of *fascia supraspinata* to the superior border of scapula, to the fascial sheath of the subclavius and to *lig. coracoclaviculare*. Inferiorly, it is enclosed by the scapular spine. Laterally, at the base of the acromion and under the acromioclavicular articulation, the supraspinal compartment opens into the infraspinous and subdeltoid cellular spaces. The contents of the supraspinous space (compartment) are *the supraspinatus, a., v. et n. suprascapularis*.

The infraspinous osteofibrous compartment is formed by the proper fascia and the scapula beneath the spine of scapula. The *fascia infraspinata* is tightly accreted with the medial border of scapula, spine of scapula and lateral border of scapula. In the compartment, there are *m. infraspinatus, m. teres minor*, a small layer of cellular tissue located between muscles and the bone, as well as vessels and nerves: *a. et v. suprascapularis, a. circumflexa scapulae, n. suprascapularis.* Here also run the branches of *r. profundus a. transversae colli*, perforating the proper fascia at the medial border of scapula. The circumflex scapular artery on its way from the axillary fossa also perforates this fascia, but at the lateral border of scapula.

The branches of the above called three arteries anastomose with one another in the infraspinous cellular tissue and in the depth of the infraspinatus. As a result, the so-called **scapular arterial collateral circle** is formed. When the blood flow through the main, axillary, artery is hampered or stopped, above (proximal of) the place where the subscapular artery (*a. subscapularis*) branches off from the axillary artery, due to the anastomoses of the scapular circle, blood circulation of all the upper limb can be preserved. In more detail, see the section «Collateral blood circulation in shoulder girdle».

From the angle of the scapula, from the lower half of its lateral border and from the infraspinous fascia, the teres major arises. Its superior border is adjacent to the inferior border of the teres major covered by the infraspinous fascia; between them the interstice is formed. At the middle of its length, the teres major is crossed posteriorly by the tendon of the long head of the triceps brachii that traces forwards under the teres minor. The interstice between the *mm. teretes* is divided thus into two departments: medial **(the trilateral foramen)** and lateral **(the quadrilateral foramen)** located within the limits of the deltoid region (fig. 2.8).

The trilateral foramen has the following borders **from the scapular aspect**: inferiorly — teres major, superiorly — teres minor, and from the lateral side — the tendon of the long head of the triceps brachii. Through this foramen, from the axillary region into the scapular one, *a. circumflexa scapulae* passes. Further, it pierces a fascial sheath for the teres minor and splits into branches in the muscles of the infraspinous fossa.

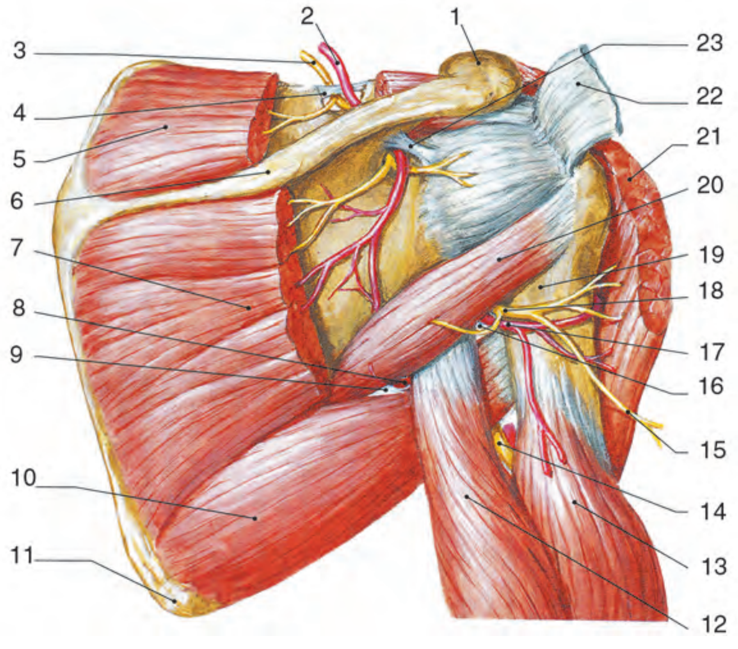

Fig. 2.8. The subfascial structures of the scapular region. The supraspinous and infraspinous compartments: *1 — acromion; 2 — a. suprascapularis; 3 — n. suprascapularis; 4 — lig. transversum scapulae superius; 5 — m. supraspinatus; 6 — spina scapulae; 7 — m. infraspinatus; 8 — a. circumflexa scapulae; 9 —* ***foramen trilaterum****; 10 — m. teres major; 11 — angulus inferior scapulae; 12 — m. triceps brachii, caput longum; 13 — m. triceps brachii, caput laterale; 14 — n. radialis et a. profunda brachii; 15 — n. cutaneus brachii lateralis superior; 16 —* ***foramen quadrilaterum****; 17 — a. circumflexa humeri posterior; 18 — n. axillaris; 19 — collum chirurgicum humeri; 20 — m. teres minor; 21 — m. deltoideus; 22 — m. infraspinatus, tendo; 23 — lig. transversum scapulae inferius*

The following layer is the **scapula.**

Subscapular space. The subscapularis lies at the anterior side of the scapula in the osteofascial compartment formed by accretion of the subscapular fascia with the borders of scapula. The subscapularis, going on as a rather tight tendon, passes to the subdeltoid space, in which the tendon is attached to the smaller tubercle of the humerus. Up to the place of its attachment, the tendon closely adjoins the anterior part of the capsule for the shoulder joint. Under the tendon of the subscapularis lies a rather large synovial bursa, *bursa synovialis subscapularis*, all the time connected with the cavity of the capsule for the shoulder joint/ rotator cuff. The anterior surface of the subscapularis, together with its fascia, takes part in forming the posterior wall of the axillary fossa and the posterior wall of the antescapular cellular space, which is a continuation of the axillary space in the dorsal direction. The anterior wall of this space is the serratus anterior covered with the proper fascia, *fascia thoracica*.

Relation of cellular tissue of scapular region with adjacent regions

- Alongside the suprascapular fascicle — with the cellular tissue of the lateral triangle of the neck;
- Alongside *a. et v. circumflexa scapulae*, through the trilateral foramen — with cellular tissue of the axillary fossa;
- Alongside the tendons of the supraspinous and infraspinous muscles — with the cellular tissue of the subdeltoid space.

DELTOID REGION, *REGIO DELTOIDEA*

The region is located outwards from the scapular one, and corresponds to the contour of the deltoid muscle that covers the shoulder joint and the upper third of the humerus.

Surface landmarks are the clavicle, acromion and spine of scapula, the deltoid eminence, its anterior and posterior borders, and the deltopectoral sulcus. At dislocations in the shoulder joint, this deltoid eminence smooths out and turns into a fossa.

Limits. The superior — the lateral third of the clavicle, the acromion and the lateral third of the scapular spine. The inferior — the line on the external surface of the arm connecting the inferior borders of the pectoralis major and the latissimus dorsi. The anterior and posterior limits correspond to the borders of the deltoid.

Projections. Alongside the deltopectoral sulcus, the lateral subcutaneous vein of the arm, *v. cephalica,* is projected. Along a vertical line, drawn downwards from the posteroexterior angle of the acromion up to the cross with the posterior border of the *m. deltoideus* (in average, 6 cm; with the upper limb abducted from the trunk to the right angle, this distance will be 2.5–3.0 cm), a point is found through which, transverse to the arm, the neurovascular fascicle of the region — *n. axillaris et aa. circumflexae humeri anterior et posterior* is projected. At the same level lies the surgical neck of the humerus. The projection of the *recessus axillaris*, or the lower diverticulum of the articular bursa of the shoulder joint, is identified by a point, located on the same vertical line 4 cm beneath posterior angle of the acromion, i.e. 2 cm upward of the projections of the axillary nerve. Here, in case of inflammation (arthritis) of the shoulder joint, tenderness is identified while pressing. This point is located under the posterior border of the deltoid.

Layers

The skin is rather thick, and slightly movable.

The subcutaneous adipose tissue is solid, especially near the posterosuperior border of the region, and has a cellular structure. Approximately at the middle of the posterior border of the deltoid, from under the proper fascia into the subcutaneous cellular tissue, the branch of the axillary nerve, *n. cutaneus brachii lateralis superior* comes out.

The superficial fascia is feeble.

The proper fascia, *fascia deltoidea*, at the superior limit of the region is tightly united with the clavicle, acromion and spine of the scapula. At the anterior and inferior limits, it goes on as the *fascia pectoralis* and *fascia brachii*. Along the anterior limit of the region, in *sulcus deltopectoralis*, in the split of the proper fascia, lies *v. cephalica* that runs further to the subclavian region.

The proper fascia has superficial and deep laminae forming a capsule for the deltoid. Both laminae are connected with numerous fascial intersections splitting separate fibers of the muscle. In two places these intersections are especially prominent; they split three portions of the deltoid, according to the places of its attachment: the clavicular portion, *pars clavicularis*, the acromial, *pars acromialis*, and the spinal, *pars spinalis*.

The subdeltoid cellular space is situated between the deep lamina of the *fascia deltoidea* (on the deep surface of the deltoid) and the proximal end of the humerus with the shoulder joint and its capsule. In the cellular tissue of the space, lie the neurovascular fascicle and the subdeltoid synovial bursa, *bursa subdeltoidea*, surrounding the greater tubercle of the humerus (fig. 2.9).

To this tubercle the tendons of the supraspinatus, infraspinatus, and teres minor attach. As a rule, the subdeltoid bursa is united with another mucous bursa located under the acromion (*bursa subacromialis*).

The subdeltoid cellular space goes on upwards under the acromion and further backwards into the subtrapezoid space.

Topography of vessels and nerves. The main element of the neurovascular fascicle is *n. axillaris*, the branch of the posterior fascicle of the brachial plexus. It innervates the deltoid. The fascial sheath of the fascicle is connected with the deep lamina of the deltoid fascia. Coming from the axillary fossa through the *foramen quadrilaterum*, *n. axillaris* adjoins the axillary recess, *recessus axillaris* of the capsule for the shoulder joint, and then circumflexes the surgical neck of the humerus posteriorly to the front.

The *n. axillaris* lies proximal to the posterior humeral circumflex artery (fig. 2.10).

On the deep surface of the deltoid, *a. circumflexa humeri posterior* anastomoses with *a. circumflexa humeri anterior* also coming out of the axillary fossa, — but across the anterior surface of the surgical neck of the humerus. Both arteries anastomose also with the deltoid branch of *a. thoracoacromialis.* These anastomoses provide a collateral blood circulation when the blood flow through the axillary artery is hampered

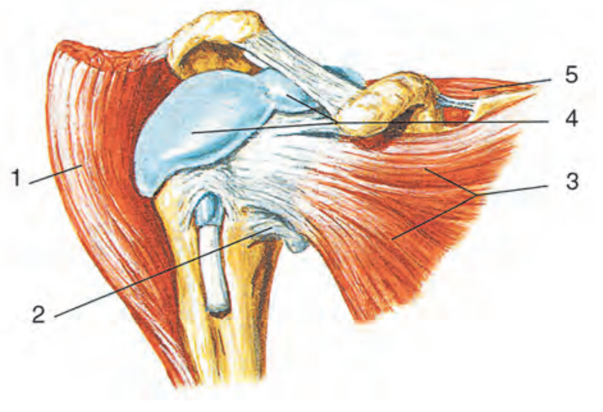

Fig. 2.9. Synovial bursae of the subdeltoid space: *1 — m. deltoideus; 2 — recessus axillaris; 3 — m. subscapularis; 4 — bursa subdeltoidea et subacromialis; 5 — m. supraspinatus*

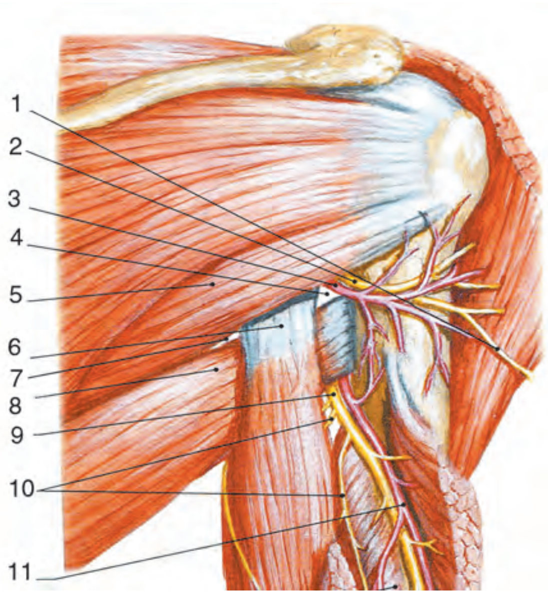

Fig. 2.10. *N. axillaris* exiting into the subdeltoid space: *1 — n. cutaneus brachii lateralis superior; 2 — n. axillaris; 3 — a. circumflexa humeri posterior; 4 — foramen quadrilaterum; 5 — m. teres minor; 6 — tendo capitis longi m. tricipitis brachii; 7 — foramen trilaterum; 8 — m. teres major; 9 — n. radialis; 10 — n. radialis, rami musculares; 11 — a. profunda brachii*

in the area between the thoracoacromial artery and both circumflex humeral arteries. Another important anastomosis is between the deltoid branch of the thoracoacromial artery and the deltoid branch of the deep artery of the arm. This anastomosis plays an important role in case of hampered blood flow in the axillary — brachial artery in the area between the subscapular artery and deep artery of the arm.

When the humerus is fractured at the level of the surgical neck, the axillary nerve may be strangulated. Sometimes, the nerve becomes surrounded by the developing callus and compressed by it. It is also probable that the nerve be involved in the inflammatory process in case of purulent disease of the shoulder joint and the break of pus from the capsule through the recessus axillaris. In all such cases there may appear cutaneous sensitivity dysfunction in the zone of branches of n. axillaris and, mostly important, paresis or paralysis of the deltoid. It will be seen by the impossibility to abduct the arm to the horizontal level (loss of function of the deltoid).

Relations of cellular tissue of subdeltoid space with adjacent regions

- Alongside of the neurovascular fascicle and further through the quadrilateral foramen, the subdeltoid space is connected with the axillary one.
- Alongside of the tendons of the supraspinatus and infraspinatus, the cellular tissue is connected with the supraspinal and subspinal spaces of scapula.
- At the top, the cellular tissue proceeds under the acromion and further backwards into the subtrapezoid space.

SHOULDER JOINT, *ARTICULATIO HUMERI*

The shoulder joint is located under the roundness of the deltoid. It connects the humerus, and through it, the entire free upper limb, with the shoulder girdle; in particular, with the scapula.

Surface landmarks. First, it is the deltoid. It is almost always possible to find the *sulcus deltopectoralis* and to palpate the posterior border of the muscle. In all humans, irrespective of the amount of subcutaneous adipose tissue, the acromion is palpable, especially its posterior angle.

Beneath the lateral part of the clavicle, in depth of the *sulcus deltopectoralis*, the *processus coracoideus* is felt.

The articular interstice projects frontally upon the apex of the coracoid process, from the outside — along a line joining the acromial extremity of the clavicle to the coracoid process, posteriorly — under the acromion, upon the interstice between acromial and spinal parts of the deltoid.

The articulating areas are the glenoid cavity of the scapula, *cavitas glenoidalis*, and the head of the humerus, *caput humeri*.

At the thickened lateral angle of scapula, the slightly deepening glenoid cavity lies (fig. 2.11).

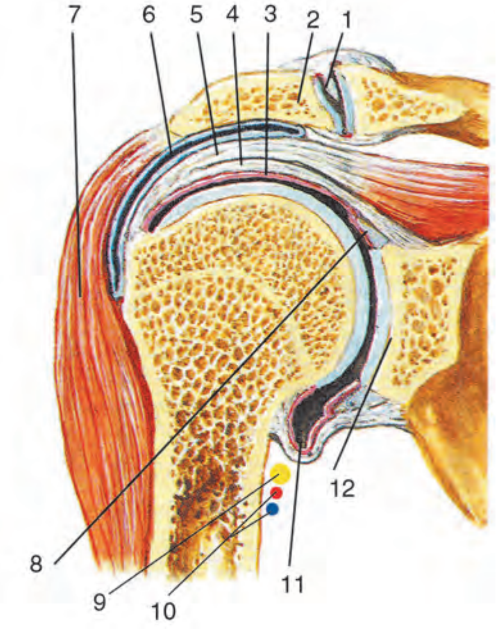

Fig. 2.11. The shoulder joint in a sagittal section: *1 — articulatio acromioclavicularis; 2 — acromion; 3 — capsula articularis, membrana synovialis; 4 — membrana fibrosa; 5 — m. supraspinatus, tendo; 6 — bursa subdeltoidea; 7 — m. deltoideus; 8 — labrum glenoidale; 9 — n. axillaris; 10 — a. et v. circumflexa humeri posterior; 11 — recessus axillaris; 12 — cavitas glenoidalis*

Above the upper border of the cavity, there is the supraglenoid tubercle, *tuberculum supraglenoidale*, a place of attachment of the tendon of the long head of *m. biceps brachii*. By the lower border of the glenoid cavity, the infraglenoid tubercle, *tuberculum infraglenoidale*, is located from which the long head of *m. triceps brachii* takes its origin.

From the superior border of scapula, close to the glenoid cavity, the coracoid process, *processus coracoideus* branches off. This process is the place where two muscles take their origin: *m. coracobrachialis* and *caput breve m. bicipitis brachii*. Besides the muscles, a ligament, *lig. coracoacromiale* branches off from the process, strained between the lateral end of the coracoid process and the middle part of the medial surface of the acromion of scapula. The ligament is tight, 0.8–1 cm wide, of whitish color. As it lies over the joint, this ligament, together with the acromial and coracoid processes, forms the coracoacromial arch. This arch limits abducting the arm more than to the right angles in the shoulder joint. The limb is lifted up higher only together with the scapula.

Superiorly, the humerus has a spherical articular head which is separated from the rest of the bone by a narrow groove called the anatomical neck. Just behind it, there are two tubercles, the greater one of which, *tuberculum majus*, lies laterally, and the smaller, *tuberculum minus*, is a little to the front from it. Between the tubercles a groove, *sulcus intertubercularis* is located in which passes a tendon of the long head of the biceps brachii. Right beneath the both tubercles, on the borderline with the diaphysis, the surgical neck of the humerus is situated.

In the shoulder joint, there is a large discrepancy between the almost flat glenoid cavity and the spherical head of the humerus. To some extent, this discrepancy is lessened by the cartilaginous glenoid labrum, *labrum glenoidale*, that enlarges the volume of the cavity without restricting mobility of the joint and softens impacts and commotions when the head of the humerus is moved. Nevertheless, the remaining incongruence is the cause of dislocations of the humerus that occur more often than in any other joint.

The articular capsule of the shoulder joint is loose and rather thin. At the scapula it is attached to the osseous border of the articular cavity and, enveloping the head of the humerus, ends on the anatomical neck. The both tubercles are situated outside of the cavity of the joint. Interiorly and inferiorly the articular capsule attaches much lower, at the level of the surgical neck of the humerus, forming the so-called axillary recess, *recessus axillaris*.

The fibrous layer of the articular capsule consists of thickened and thin areas. The thickened ones are formed due to ligaments, the most solid of which is *lig. coracohumerale;* it arises from the lateral border of the coracoid process and directs to the greater and smaller tubercles of the humerus. The so-called glenohumeral ligaments, *ligg. glenohumerale* [Flood]: superior, middle and inferior — are rather feeble. Between the ligaments, there are so-called 'weaknesses'. The capsule between the middle and inferior ligaments is especially thin. This place is the anterior 'weakness' of the capsule (fig. 2.12).

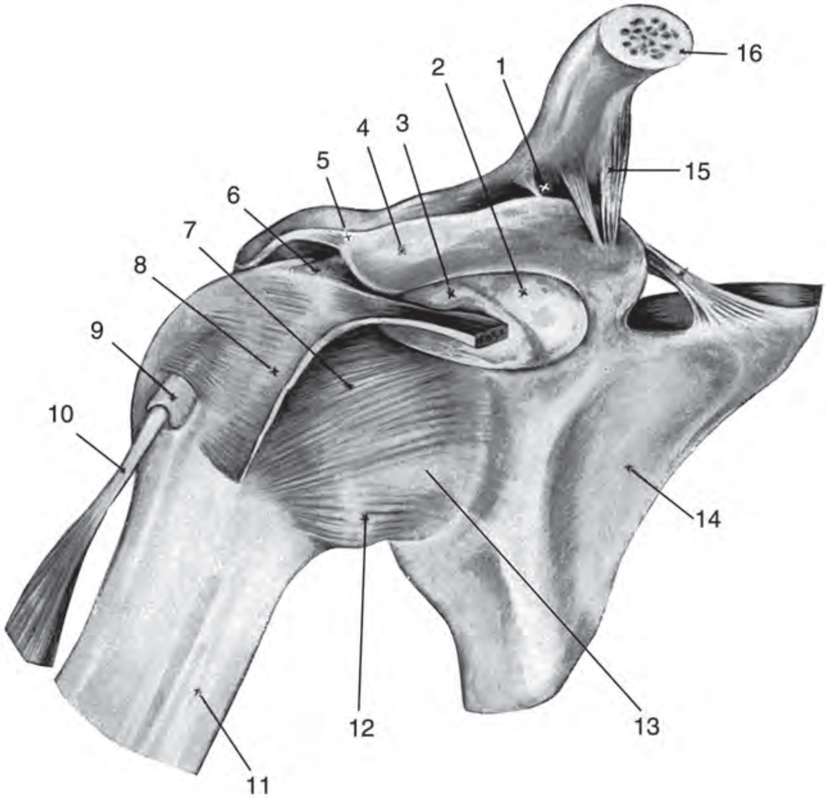

Fig. 2.12. The shoulder joint (the frontal view): *1 — lig. trapezoideum; 2 — bursa subcoracoidea; 3 — bursa tendinis m. subscapularis; 4 — processus coracoideus; 5— lig. coracoacromiale; 6 — lig. coracohumerale; 7— lig. glenohumerale medium; 8 — tendo m. subscapularis; 9 — vagina mucosa intertubercularis; 10 — m. biceps (caput longum); 11 — humerus; 12 — lig. glenohumerale inferius; 13 —* the anterior 'weakness' of the capsule of the joint; *14 — scapula; 15 — lig. transversum scapulae superius; 16 — clavicula*

In supporting the capsule for the shoulder joint, tendons of muscles surrounding the joint are very important (fig. 2.13.).

The supporting role of muscles is carried out differently. So, the biceps brachii, the coracobrachialis and the deltoid have no direct relation to the capsule of the joint, but they help to hold together the articular ends of the scapula and humerus.

Other muscles are connected right to the capsule of the joint. The tendon of the supraspinatus, going from the same-named compartment, passes under the *lig. coracoacromiale*, covers the joint superiorly and outside and attaches to the upper part of the greater tubercle of the humerus.

Posteriorly, the shoulder joint is covered with the tendon of *m. infraspinatus* attaching to the greater tubercle below the place of attachment of the *m. supraspinatus*,

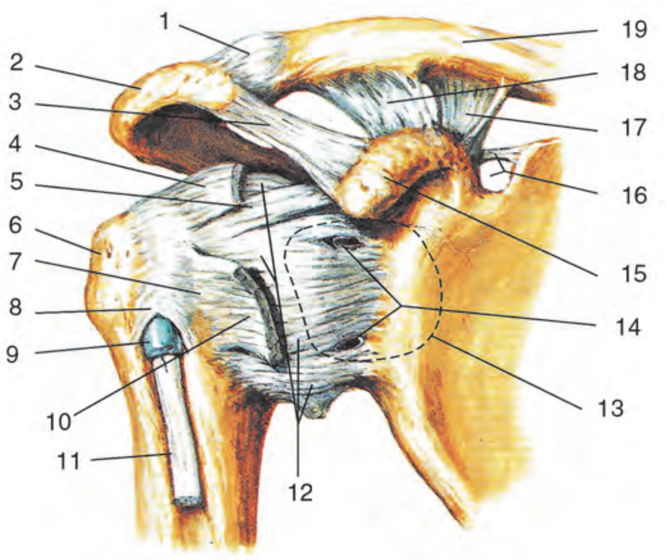

Fig. 2.13. The ligaments and tendons supporting the shoulder joint: *1 — capsula articularis acromioclaviculare; 2 — acromion; 3 — lig. coracoacromiale; 4 — m. supraspinatus, tendo; 5 — lig. coracohumerale; 6 — tuberculum majus; 7 — tuberculum minus; 8 — lig. transversum humeri; 9 — vagina tendinis intertubercularis; 10 — m. subscapularis, tendo; 11 — tendo m. bicipitis brachii (caput longum); 12 — ligg. glenohumeralia; 13 —* the dotted line shows the boundaries of the *bursa subtendinea m. subscapularis; 14 — connection of bursa subtendinea m. subscapularis with the cavity of the joint; 15 — proc. coracoideus; 16 — lig. transversum scapulae superius et incisura scapulae; 17 — lig. conoideum; 18 — lig. trapezoideum; 19 — clavicula*

and the tendon of *m. teres minor*, which attaches to the greater tubercle lower than the tendon of *m. infraspinatus*.

In front of the shoulder joint, the broad and flat tendon of the subscapularis lies, attaching to the smaller tubercle of the humerus.

Thus, it is notable that superiorly and posteriorly the capsule of the joint is supported by ligaments and tendons of muscles while inferiorly and from inside there is no such support. In most cases, it substantially preconditions dislocation of the head of the humerus forwards and inwards.

Significant amount of synovial bursas making sliding system of musculotendinous structures is situated around the joint.

The most stable and connected with the cavity of the joint are the subscapular bursa, *bursa subtendinea m. subscapularis*, and the coracobrachial bursa, *bursa m. coracobrachialis* lying more superficially, over the former. Quite often, these bursas unite with one another. In fact, the subscapular bursa can be considered as an extra-articular diverticulum of the synovial membrane of the shoulder joint. There is one more diverticulum of the synovial membrane, intertubercular. The synovial membrane tightly envelops the tendon of the long head of the biceps brachii, which traces from the scapula through the whole cavity of the shoulder joint and can reach the surgical neck of the humerus. At the level of the greater and smaller tubercles of the humerus, the tendon passes through the sulcus between them and is covered frontally, over the synovial sheath, by tendinous fibers of the subscapularis, infraspinatus and teres minor.

Anteriorly, outside and behind, *m. deltoideus* covers the shoulder joint, not joining with the capsule. Under the muscle, in the subdeltoid cellular space, there are also synovial bursas. In particular, upwards of the greater tubercle of the humerus, over the tendon of the supraspinatus, the subdeltoid synovial bursa lies, and under the acromion — the subacromial one. Sometimes they unite, forming the common subdeltoid bursa.

The axillary neurovascular fascicle, *a. et v. axillares* with the nerves, surrounding them, — lies inwards from the *processus coracoideus* and *m. coracobrachialis*. Its placing is taken into account at the frontal access to the joint.

Directions of spreading pus

The subdeltoid cellular tissue surrounding the shoulder joint is called periarticular and is a place where chronic inflammations of the joint localize and purulent periarthrites spread.

Purulent process spreads:

- into the osteofascial sheath of the subscapularis (the subscapular bursa is also involved in the process and broken through);
- into the axillary fossa and into the subtrapezoid cellular space (if the *bursa m. coracobrachialis* is involved in this process) with its following break leading to pus leakage);
- as the intertubercular diverticulum is tightly covered with tendons, pus seldom breaks through it. If however the break takes place, pus leaks into the anterior cellular space of the arm, with subsequent leakages alongside the neurovascular fascicles.

COLLATERAL BLOOD CIRCULATION IN REGIONS OF SHOULDER GIRDLE

In regions of the shoulder girdle, around of the shoulder joint, there are two plexi of collaterals — the scapular and the deltoacromial.

The so-called scapular **arterial collateral circle** belongs to the first of them. It consists of *a. suprascapularis* (from *truncus thyrocervicalis* out of *a. subclavia), r. profundus a. transversae colli* (out of *a. subclavia*) and *a. circumflexa scapulae* from *a. subscapularis* (out of *a. axillaris*). The branches of the listed three arteries anastomose in the subspinal cellular tissue and in the depth of the infraspinatus (fig. 2.14).

When blood flow through the main — axillary — artery is hampered or stops upwards (proximal) of the place where the subscapular artery (*a. subscapularis*) branches off from it, blood circulation can be preserved in the entire upper limb due to anastomoses of the scapular circle. It happens the following way: from the

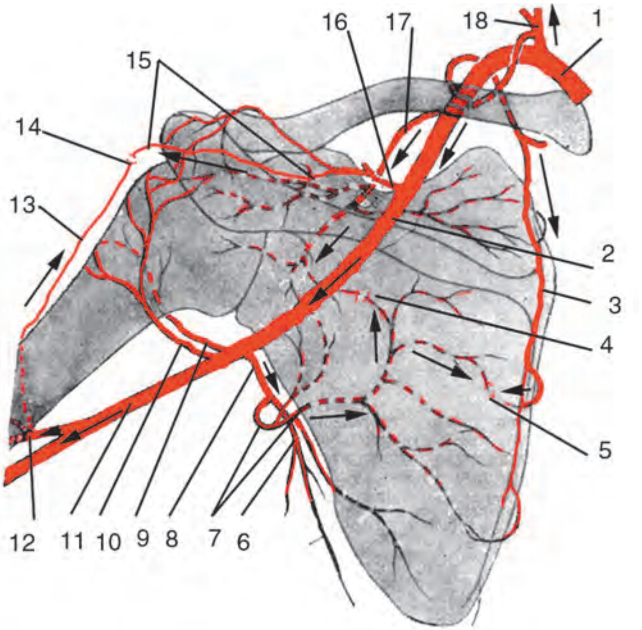

Fig. 2.14. The arteries of the shoulder girdle at the normal blood flow along the great artery. Axillary fossa aspect. The arrows show the blood flow direction: *1 — a. subclavia; 2 — a. axillaris; 3 — ramus profundus a. transversae colli; 4 —* the anastomosis between *a.suprascapularis and a. circumflexa scapulae; 5 —* anastomosis between *ramus profundus a. transversae colli and a. circumflexa scapulae; 6 — a. thoracodorsalis; 7 — a. circumflexa scapulae; 8 — a. subscapularis; 9 — a. circumflexa humeri posterior; 10 — a. circumflexa humeri anterior; 11 — a. brachialis; 12 — a. profunda brachii; 13 — ramus deltoideus a. profundae brachii; 14 —* anastomosis between *ramus deltoideus a. profundae brachii and ramus deltoideus a. thoracoacromialis; 15 — ramus deltoideus a. thoracoacromialis; 16 — a. thoracoacromialis; 17 — a. suprascapularis; 18 — truncus thyrocervicalis*

system of the subclavian artery through its branches, the suprascapular artery and the deep branch of transverse artery of neck, blood comes into the infraspinous fossa; then, through the anastomoses with *a. circumflexa scapulae*, already retrograde, it passes into the subscapular artery, then into the axillary artery, and further — now not retrograde — but as usual, through all arteries of the upper limb (fig. 2.15).

> ***It should be emphasized that as almost in every region of the limbs, in the scapular region each artery is accompanied by two same-named veins. It also concerns the scapular circle, which is therefore double. Such a circle plays an important part in compensating the venous outflow from the upper limb at injured axillary vein as such injury is rather frequent during lymph nodes removal (lymphodissection) at mastectomy for breast cancer surgery.***

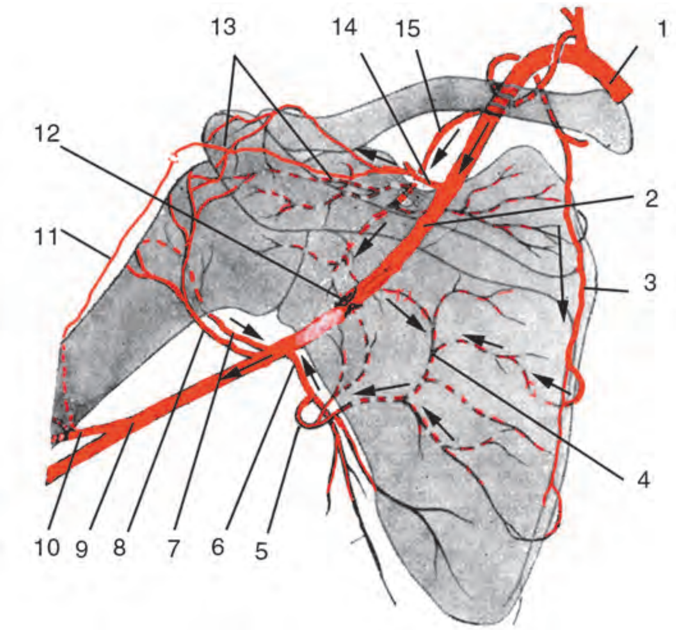

Fig. 2.15. The collateral blood flow at the occluded axillary artery proximal to *a. subscapularis* branching off (the scapular collateral circle). The arrows show the blood flow direction: *1 — a. subclavia; 2 — a. axillaris; 3 — ramus profundus a. transversae colli; 4 —* anastomosis between *a. suprascapularis, ramus profundus a. transversae colli and a. circumflexa scapulae; 5 — a. circumflexa scapulae; 6 — a. subscapularis; 7 — a. circumflexa humeri posterior; 8 — a. circumflexa humeri anterior; 9 — a. brachialis; 10 — a. profunda brachii; 11 — ramus deltoideus a. profundae brachii;* 12 — *a. axillaris* occlusion proximal to *a. subscapularis* branching-off; *13 — ramus deltoideus a. thoracoacromialis;14 — a. thoracoacromialis; 15 — a. suprascapularis*

To the second collateral network — **deltoacromial circle** — the acromial and deltoid branches of *a. thoracoacromialis*, both circumflex humeral arteries, and the deltoid branch of deep artery of arm belong. These branches anastomose mainly in the depth of the deltoid and connect the system of the axillary artery with that of the deep artery of arm (fig. 2.16).

If a stenosis (narrowing) of the axillary artery progresses slowly, in the area between the circumflex humeral arteries and the place of the deep artery of arm branching off from the brachial artery, the only possible way to develop the collateral blood circulation in the upper limb is through the *r. deltoideus a. profunda*e *brachii*. The small diameter of the listed vessels explains why this plexus can compensate the broken blood flow through the main artery <u>only in case of slow and gradual development of the process</u> that leads to this break (growth of an atherosclerotic plaque).

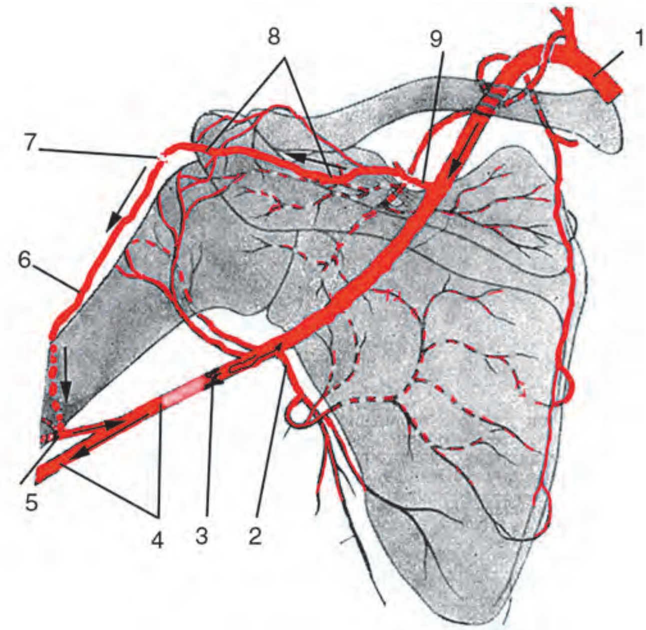

Fig. 2.16. The collateral blood flow at the axillary artery occluded distal to *a. subscapularis* branching off (acromio-deltoid way). The arrows show the blood flow direction: *1 — a. subclavia; 2 — a. subscapularis; 3 —* the place of *a. axillaris* occluded distal to *a. subscapularis'* branching-off; *4 — a. brachialis; 5 — a. profunda brachii; 6 — ramus deltoideus a. profundae brachii; 7 —* anastomosis between *ramus deltoideus a. profundae brachii and ramus deltoideus a. thoracoacromialis; 8 — ramus deltoideus a. thoracoacromialis; 9 — a. thoracoacromialis*

ANTERIOR REGION OF ARM, *REGIO BRACHII ANTERIOR*

Surface landmarks. The places where the pectoralis major and latissimus dorsi attach to the humerus, the biceps brachii, the medial and lateral epicondyles of the humerus, the medial and lateral sulci at the respective borders of the biceps brachii. The lateral sulcus proximally goes on as the deltopectoral sulcus. Distally, both sulci pass on into the anterior region of elbow.

Alongside the medial sulcus, the humerus can be palpated; the brachial artery can be pressed to it there by a finger to stop hemorrhage and to do effective hemostasis by a tourniquet as well.

Limits. The superior limit of the region goes along a line connecting the point of attachment of the pectoralis major and latissimus dorsi to the humerus. The inferior limit is drawn through the points located 4 cm upwards of epicondyles of the humerus; the lateral and medial limits correspond to the vertical lines drawn up from the epicondyles.

Projections. The projection of *a. brachialis* and *n. medianus* is constructed from the point on the borderline of the anterior and middle thirds of the line, identifying the superior limit of the region, up to the middle of the bent of the elbow (*fossa cubiti*) or, more exactly, 1 cm medial of the tendon of *m. biceps brachii*. When the *sulcus bicipitalis medialis* is well seen, the projective line of the brachial neurovascular fascicle coincides with it. The *v. basilica* is projected upon the same line.

The projection of *n. ulnaris* in the upper third of the arm corresponds to the projection of the main neurovascular fascicle, and from the point between the upper and middle thirds directs to the medial side up to the point located 1 cm lateral of the medial epicondyle apex (at the base of the epicondyle).

The *n. radialis* is projected upon the skin of the anterior surface in the lower third of the arm alongside the lateral sulcus. (The lateral sulcus of the arm is frequently difficult to find at examination because of excessive subcutaneous adipose tissue. In such cases, the lateral limit of the anterior region of the arm is used as a projective line.)

Layers

The skin in the anterior region of the arm is rather thin, especially in the medial part of the region, and rather movable. In the skin of the medial surface of the upper half of the arm, the medial cutaneous nerve of the arm, *n. cutaneus brachii medialis* out of the medial fascicle of the brachial plexus splits into branches.

The subcutaneous adipose tissue is friable.

The superficial fascia is quite solid in the lower third of the region, where it forms a sheath for superficial neurovascular structures, but in other places it is of poor amount.

The superficial structures of the region are the following: medially (alongside the *sulcus bicipitalis medialis*) in the lower third of the arm, the medial subcutaneous vein of the upper limb goes, *v. basilica*, and near it the branches of the *n. cutaneus antebrachii medialis* run. Laterally, alongside the *sulcus bicipitalis lateralis*, on its whole length, the lateral subcutaneous vein of the upper limb traces, *v. cephalica* passing into the *sulcus deltopectoralis* at the superior limit of the region.

The proper fascia, *fascia brachii*, circumflexes the entire arm. On the borderline of the middle and lower thirds of the arm in the medial sulcus of the arm, there is an opening in the proper fascia, through which *v. basilica* enters the splitting of the fascia (the canal of Pirogoff), while the *n. cutaneus antebrachii medialis* leaves it.

From the internal surface of the proper fascia, medially and laterally, the intermuscular septa (*septa intermusculare laterale et mediale*) branch off to the humerus, therefore, two fascial compartments are formed on the arm: anterior and posterior.

The walls of the **anterior fascial compartment of the arm**, *compartimentum brachii anterius*, are: anteriorly — the proper fascia, posteriorly — the humerus with intermuscular septa attaching to it (fig. 2.17).

The contents of the anterior compartment are the following muscles: the lying deeper coracobrachialis (in the upper third of the arm), the short head of the biceps brachii and the brachialis (in the middle and lower thirds of the arm). Superficially, the long head of the biceps brachii lies. The brachialis [Casserio] is covered by the deep fascia.

The main neurovascular fascicle of the region — the brachial artery with the veins and the median nerve accompanying it — is situated first from the internal side of the coracobrachialis and then of the biceps brachii, along its whole length in the fascial sheath formed by the medial intermuscular septum.

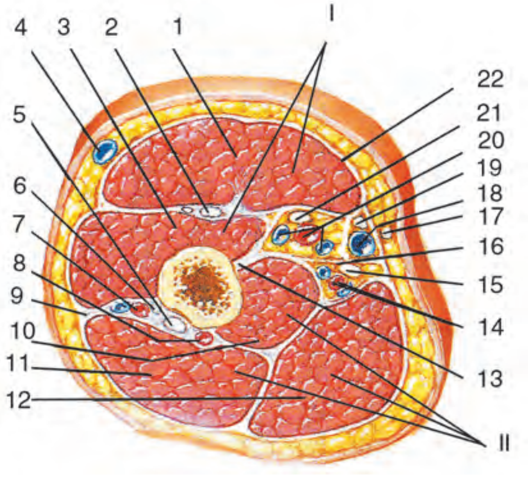

Fig. 2.17. The fascial compartments of the arm at the transverse section of the middle third: *I — compartimentum brachii anterius; II — compartimentum brachii posterius. 1 — m. biceps brachii; 2 — n. musculocutaneus; 3 — m. brachialis; 4 — v. cephalica; 5 — n. radialis; 6 — n. cutaneus antebrachii posterior; 7 — a. collateralis radialis; 8 — a. collateralis media; 9 — septum intermusculare laterale; 10 — caput mediale m. tricipitis brachii; 11 — caput laterale m. tricipitis brachii; 12 — caput longum m. tricipitis brachii; 13 — septum intermusculare mediale; 14 — a. collateralis ulnaris superior; 15 — n. ulnaris; 16 — compartimentum neurovasculare; 17 — n. cutaneus brachii medialis; 18 — v. basilica* in the Pirogoff canal*; 19 — n. cutaneus antebrachii medialis* in the Pirogoff canal*; 20 — a. et vv. brachiales; 21 — n. medianus; 22 — fascia brachii*

The posterior fascial compartment of the arm, *compartimentum brachii posterius*, is bound anteriorly by the humerus with septa, and posteriorly — by the proper fascia. In the posterior compartment *m. triceps brachii* lies.

Topography of vessels and nerves of anterior fascial compartment

In the upper third of the arm the *n. medianus* is located beside the artery lateral of it. Medial to the artery the *n. ulnaris* lies, and the *n. cutaneus antebrachii medialis* — still more medial. Inwards from the main fascicle, most medial and superficial, *v. basilica* goes which joins the fascicle at the borderline of the upper and middle thirds, right after leaving the Pirogoff canal. In the upper third of the arm, this vein runs into one of the brachial veins, or passes into the axillary region and runs into the axillary vein (fig. 2.18).

The *n. musculocutaneus* exits from the lateral side of the coracobrachialis, perforating it almost at once on its way from the axillary fossa to the anterior surface of the arm, and goes under the long head of the biceps brachii. At the borderline with the middle third, it lies on the deep fascia that covers the brachialis. On their way, the branches of *n. musculocutaneus* run to all the muscles of the anterior fascial compartment.

At the limit between the anterior region of the arm and the axillary region, right below the inferior border of the tendon of latissimus dorsi, behind the artery, a large

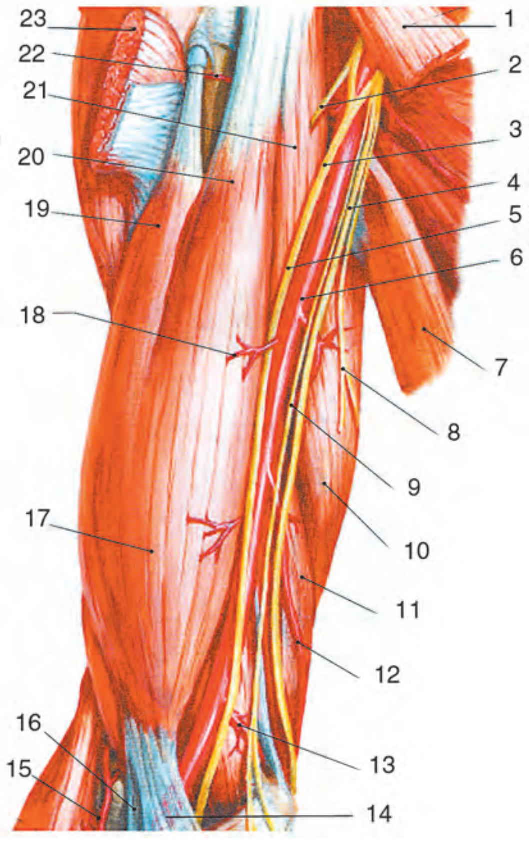

Fig. 2.18. The antero-internal surface of the arm: *1 — m. pectoralis minor; 2 — n. musculocutaneus; 3, 5 — n. medianus; 4 — n. ulnaris; 6 — a. brachialis;* 7 — *m. latissimus dorsi; 8 — n. cutaneus brachii medialis; 9 — n. cutaneus antebrachii medialis; 10 — caput longum m. tricipitis brachii; 11 — caput mediale m. tricipitis brachii; 12 — a. collateralis ulnaris superior; 13 — a. collateralis ulnaris inferior; 14 — aponeurosis bicipitalis (Pirogoff's); 15 — a. recurrens radialis;16 — tendo m. bicipitis brachii;17 — m. biceps brachii; 18 — ramus muscularis a. brachialis; 19 — caput longum m. bicipitis brachii; 20 — caput breve m. bicipitis brachii; 21 — m. coracobrachialis; 22 — a. circumflexa humeri anterior; 23 — m. pectoralis major*

trunk of the *n. radialis* is found. Almost at once, it runs into the posterior fascial compartment between the long and lateral heads of the triceps brachii.

In the upper third of the arm a large vessel — the deep artery of arm, *a. profunda brachii* branches off from the brachial artery and almost at once runs together with the radial nerve into the posterior fascial compartment. At the borderline of the upper and middle thirds of the arm, one more branch splits from the brachial artery, the superior ulnar collateral artery, *a. collateralis ulnaris superior*, further accompanying the ulnar nerve.

In the middle third of the arm, the *n. medianus* is situated in the front from the brachial artery (crossing it).

The *n. ulnaris* now goes on still more medial of the artery and at the borderline with the upper third perforates the medial intermuscular septum, passing into the posterior compartment of the arm. The *a. collateralis ulnaris superior* goes along with it.

The *n. cutaneus antebrachii medialis* also runs out of the anterior fascial compartment, entering the splitting of the proper fascia (the Pirogoff canal), from where *v. basilica* comes into the subfascial space.

The *n. musculocutaneus* traces obliquely from above downwards and from inwards to outwards between the biceps brachii and brachialis muscles.

In the lower third of the arm, the *n. medianus* runs already more medial of the artery, but beside it. Here one more branch, *a. collateralis ulnaris inferior* branches off from the artery. It goes obliquely downwards along the surface of the brachialis into the cubital region (the name of the artery is not connected with the ulnar nerve, which is not present in the anterior compartment, but identifies only the ulnar side of the limb), where it takes part in forming the cubital collateral plexus.

From the lateral side of the lower third of the arm, in the anterior compartment the *n. radialis* appears again; it perforates the lateral intermuscular septum and passes from the posterior compartment into the anterior one. It lies deeply between the brachialis and the lateral head of the triceps brachii. At the limit with the anterior region of elbow, it lies at the same depth, but now between the *m. brachialis* and *m. brachioradialis*. In these intermuscular interstices, the nerve goes with the radial collateral artery, *a. collateralis radialis* — the terminal branch of *a. profunda brachii*.

In the same place, at the borderline of the lower third of the arm with the anterior region of elbow, the terminal branch of the musculocutaneous nerve comes out from under the biceps brachii; here it has the name of the lateral cutaneous nerve of the forearm, *n. cutaneus antebrachii lateralis*. From under the proper fascia, into the subcutaneous cellular tissue it comes out more distally, within the limits of the anterior region of elbow.

Thus, within the borders of the anterior fascial compartment of the arm, only the brachial artery runs on its whole length with the veins, the median nerve, and the musculocutaneous nerve. The median nerve does not branch in this region. Other neurovascular structures pass either into the posterior compartment (the radial nerve with the deep artery of the arm in the upper third, the ulnar nerve with the superior ulnar collateral artery in the middle third), or in the subcutaneous cellular tissue of the arm (n. cutaneus antebrachii medialis).

Relations of cellular tissue of anterior region of the arm with adjacent regions

- Alongside the cellular tissue surrounding the main neurovascular fascicle, the cellular tissue of the anterior fascial compartment of the arm is proximally connected with the cellular tissue of the axillary fossa.
- In the distal direction, it is connected with the cellular tissue of the anterior region of elbow.
- Alongside the radial nerve — with the posterior fascial compartment of the arm.
- Through the Pirogoff canal — with the subcutaneous adipose tissue.

POSTERIOR REGION OF THE ARM, *REGIO BRACHII POSTERIOR*

Surface landmarks: the latissimus dorsi where it attaches to the arm, the deltoid, the eminence of the triceps brachii, and the medial and lateral epicondyles of the humerus.

Limits. The superior limit goes obliquely along the posterior border of the deltoid up to the latissimus dorsi. The inferior one is situated 4 cm upwards of the epicondyles of the humerus. Lateral and medial limits are vertical lines going upward of the epicondyles.