8 Myofascial Chains: A Model

As noted in the introduction, we believe that muscles—as the organ of myofascial chains—play an important role in all bodily functions. Their main tasks may be locomotion and maintaining balance, but we should also consider their contributions to other vital functions. They are important for respiration, digestion, and circulation. Their significance becomes obvious in the case of dysfunctions. Still's assertion that fasciae are where one should look for the origins of disorders and to begin treatment only underscores the importance of fasciae.[140]

Myofascial tissue is part of the connective tissue. It contains subcutaneous and deep fasciae, skin, muscles, tendons, and ligaments. R. Louis Schultz and Rosemary Feitis refer to the fascial system as an endless web that connects everything to everything[132]

Fascial connections are not random or anarchic, but are arranged by function. The spine plays a special role. It serves as an anchor for all fascial connections, comparable to the mast of a ship to which ropes are tied. The ropes stabilize the mast, but the mast holds the sails. As long as the ropes are taut and the mast is securely anchored, the sails can function. Our trunk consists of several fascial layers that are connected to the spine and that balance each other.

Three anterior and three posterior (muscle) fascia layers could be differentiated for the trunk:

- An outer layer consisting of:
  - Posterior: latissimus dorsi and trapezius.
  - Anterior: pectoral muscles and anterior serratus.

The main task of these muscles is to mobilize the arms.

- A middle layer consisting of:
  - Posterior: paravertebral muscles and the two posterior serratus muscles.
  - Anterior: long muscle of neck (longus colli), intercostal and abdominal muscles, psoas.

These muscles directly influence the spine (even if the intercostal and abdominal muscles use the ribs as a lever).

- A deep layer consisting of fascial structures:
  - Posterior: nuchal ligament and ligamentous apparatus of the vertebral arches.
  - Anterior: central tendon of diaphragm with serosa of the organs.

These three anterior and three posterior myofascial layers can balance the spine (the mast). If one side is hypertonic, the other side yields a little. This causes the mast to lean a little, but it is still stable. This is another example of the interplay between agonists and antagonists. We can apply the same model in the frontal plane. Myofascial structures on one side must adapt to tensions on the other side to stabilize the spine.

We are convinced that when it comes to maintaining balance, and especially when a position needs to be held over a longer period, the organism will employ all available means while minimizing the impact on other bodily functions. Thoracic respiration as well as cell respiration and venolymphatic circulation must continue to function.

The curvatures of the spine contribute to its stability. It can be assumed that vertebrae, when under strain, position the spine in a way that allows its physiologic curvatures to counteract the strain. Asymmetric strain (e.g., when carrying weight in one hand) leads to scoliotic posture.

The individual spine segments rotate around Littlejohn's vertebral pivots (see Chapter 5. These vertebral pivots can sometimes be located one segment higher or lower. As a rule, however, they are C2, C5, T4, T9, L3, and L5/S1.

Muscles need stable support to perform their work. This support is provided by other muscles, which leads to the formation of muscle chains.

In upright posture, the feet are the fixed points for muscle chains. Therefore, the feet are very important for posture.

Another factor that contributes to stability as well as enables harmonious motions in all planes is the arrangement of muscles into lemniscate shapes. A lemniscate, as per Wahrig,[165] is "an arrangement in the shape of a figure eight on its side."

In fact, except for the rectus abdominis, all muscles run along a more or less diagonal or curved course. Muscles follow each other in chains in a manner that creates loops. These loops transition harmoniously from one plane to the next.

Littlejohn's pivots and the joints of the extremities are located more or less at the crossing points of lemniscates or in the center of a loop. This illustrates that Littlejohn's model is not only structural, but also very functional.

The arrangement of muscles into lemniscates enables energy-efficient fluid motions in all planes. It allows

for the transformation of potential energy into kinetic energy and makes use of the locomotor system's elasticity. This creates a spiral or coiled spring effect (see Gait Analysis).

It also provides the additional benefit of decreasing pressure on the vessels, thorax, and abdomen.

Note: The greater the load we must transport, the greater the effort required of our muscles, because we can no longer take advantage of the momentum of the motion. At the same time, strain on joints, respiration, and circulation increases. Muscle contractions and joint blockages have the same effect.

8.1 Muscle Chains

In the previous chapters, we introduced several muscle chain models. Some of these display certain similarities, for example, Busquet and Chauffour, who both come from the "French school." Others are very distinct, for example, Myers and Denis-Struyf. Each of these authors described their model from a certain perspective.

Rolfing practitioners emphasize different aspects than osteopaths or physical therapists. We also described the mechanical aspects of cranial osteopathy, Zink patterns, and Littlejohn's model of the spine.

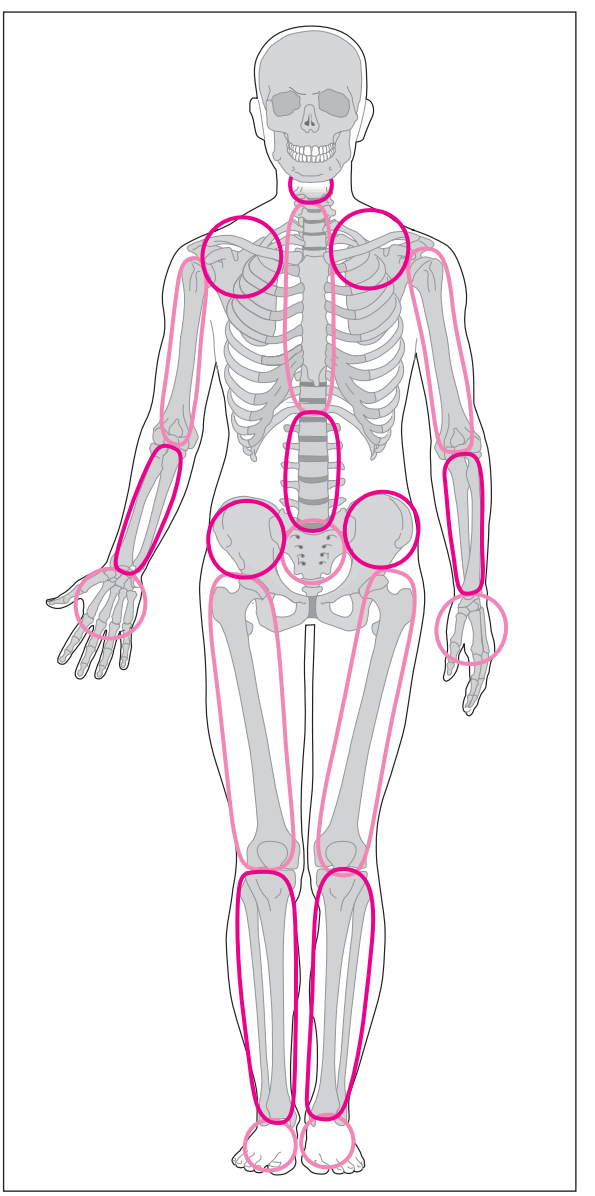
We also showed how one of the main functions of the locomotor system, walking, reproduces the behavior of the spine and the pelvis. Sutherland, Zink, and Littlejohn described this in their models.

We take it as a given that these patterns are created by muscles. This in no way contradicts Sutherland's cranial theory. Regardless of whether a pattern is triggered by the head, trunk, or extremities, the rest of the body will adapt to the same pattern (for economic reasons and to avoid taxing the brain). From a cranial perspective, this is very important for the primary respiratory mechanism (PRM) to develop without tension as much as possible. This explains why the Sutherland technique includes the segment or the cranium into the treatment of a lesion pattern: it enables unrestricted flexion and extension of the PRM.

The muscle chain model we propose differs from other models in two important aspects:

- We are convinced that flexion and extension alternate in the spine and the upper and lower extremities (▶**Fig. 8.1**). Flexion is defined as moving the two ends of a curve toward each other. Extension is defined as moving the two ends of a curve further apart.

The spine consists of three curvatures: two are concave posteriorly and one is concave anteriorly. Therefore, cervical spine (cervical spinal column [CSC]) flexion is a posterior flexion, thoracic spine (thoracic spinal column [TSC]) flexion is an anteflexion (anterior flexion), and lumbar spine (lumbar spinal column [LSC]) flexion is a posterior flexion again. This perspective of flexion and extension of the spine is interesting because it concurs with Sutherland's model. Cranial flexion corresponds to extension of the spine, which represents extension of the three curves. Cranial extension is the opposite.



▶ **Fig. 8.1** Motor units.

The upper extremities also present consistent reversal of flexion and extension (upper arm extended, elbow flexed, fist extended and fingers flexed; e.g., arm position when writing).

In our view, the neutral lower arm position is halfway between pronation and supination, with a slight flexion of the elbow.

- We think that there are only two muscle chains in each half of the body:
  - One flexion chain.
  - One extension chain.

As described by Sutherland, external rotation and abduction are associated with flexion, and internal rotation and adduction are associated with extension.

This creates the following combinations:

- Flexion + abduction + external rotation.
- Extension + adduction + internal rotation.

Please note: We would like to emphasize again that cranial flexion corresponds to extension in the parietal plane.
The arrangement of muscles into lemniscates provides for continuity of myofascial chains between the individual spine segments. This creates connections between left and right. The same applies for the extremities.

Inhibition of antagonists and the crossed stretch reflex constitute the neurophysiological basis for the development of torsion patterns.

Before describing muscle chains, we would like to illustrate the functional motor units of the skeleton.

Cranium

- Sphenoid with facial and frontal bones.
- Occiput with temporal bones, parietal bones, and mandible.

Spine

- Atlas and axis.
- C3–T4.
- T4–T12.
- T12–L5.
- Sacrum.

Lower Extremity

- Ilium.
- Thigh.
- Lower leg.
- Upper ankle joint.
- Lower ankle joint and foot.

Upper Extremity

- Shoulder blade.
- Upper arm.
- Lower arm.
- Wrist.
- Fingers.

These individual units work together like a cogwheel.

Before we assign muscles to muscle chains, we would like to point out again that the brain does not know individual muscles, only functions. Motions are performed by muscle groups (agonists and synergists).

For motions that do not take place in one consistent plane, the participating muscles can change. Polysegmental muscle innervation also makes it possible for only part of a muscle to participate in the motion. It can be difficult to assign individual muscles to a motion, especially in the extremities and in the distal areas of the arms and legs. If a clear diagnosis cannot be obtained through visual examination, therapists sometimes need to palpate and compare the individual compartments.

The practical part of this book illustrates some simple tests to identify the dominant muscle chain.

Flexion Chain

Dominant flexion chains (▶**Figs. 8.2, 8.3, 8.4, 8.5**) are found together with a cranial mechanism in extension (internal rotation).

Cranium

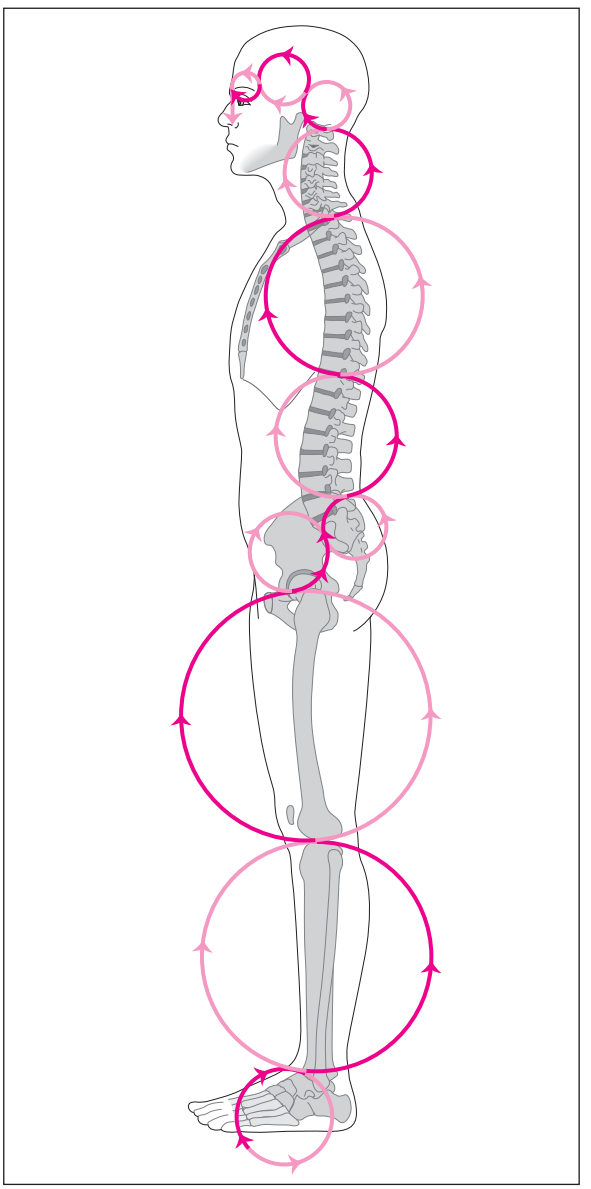
- Occipital bone posterior.
- Sphenobasilar synchondrosis (SBS) low.
- Sphenoid: body low.
- Greater wing of sphenoid bone posterior and medial.
- Peripheral cranium bones in internal rotation.

Spine

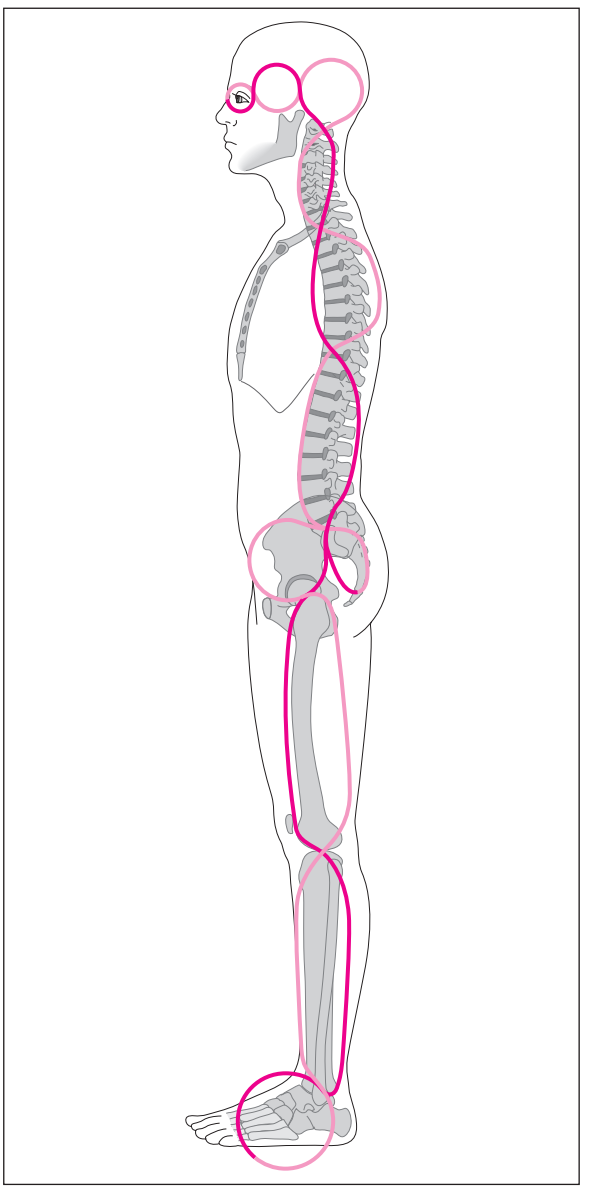
- **Occipitoatlantoaxial (OAA)**: Occiput is in flexion; atlas is relatively anterior.
  Responsible muscles: rectus capitis posterior and long muscle of head (longus capitis).

Note: The central tendon can also pull the SBS into extension. It is not a muscle, but the weight of the organs can create traction toward inferior. This is the case with this pattern because the thorax is in expiration position and cannot assist in lifting the organs.

- **C3–T4:** In extension, lordosis is increased globally.
  Responsible muscles: deep paravertebral muscles between C3 and T4, semispinal muscle of head, longissimus muscle of head, splenius muscle of head (splenius capitis), and splenius muscle of neck (splenius cervicis).



▶ **Fig. 8.2** Behavior of individual motor units with dominance of flexion pattern (*light red*) and extension pattern (*dark red*).



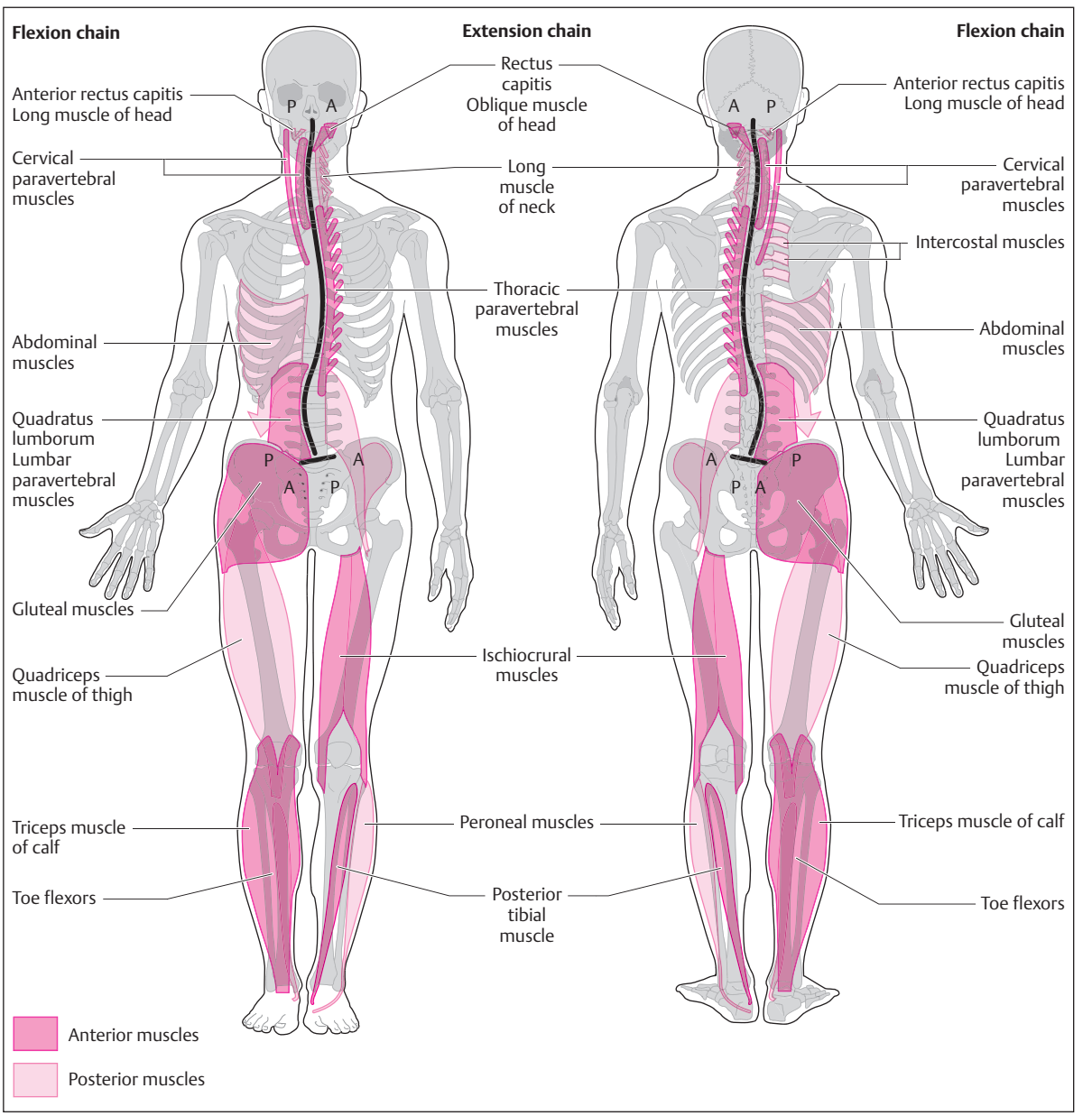
▶ **Fig. 8.3** Flexion chain (*dark red*) and extension chain (*light red*).

- **T4–T12:** Thoracic vertebrae are in flexion and ribs are in the expiration position.
  Responsible muscles: intercostal and abdominal muscles.

  Note: It may surprise some readers that we view abdominal muscles as thoracic muscles. Embryologically, they belong to the thoracic segments from which they are innervated (T5–L1). They pull the thorax into flexion via their connection with the last seven ribs.
- **T12–L5:** The lumbar spine is extended.
  Responsible muscles: lumbar paravertebral muscles and quadratus lumborum.

  Note: The quadratus lumborum maintains continuity for this chain through its connection with the 12th rib and the abdominal fascia.
- **Sacrum:** The sacrum performs a nutation. Its base moves forward and downward and the coccyx moves backward and downward.
  Responsible muscles: multifidus muscles in the lumbosacral area.

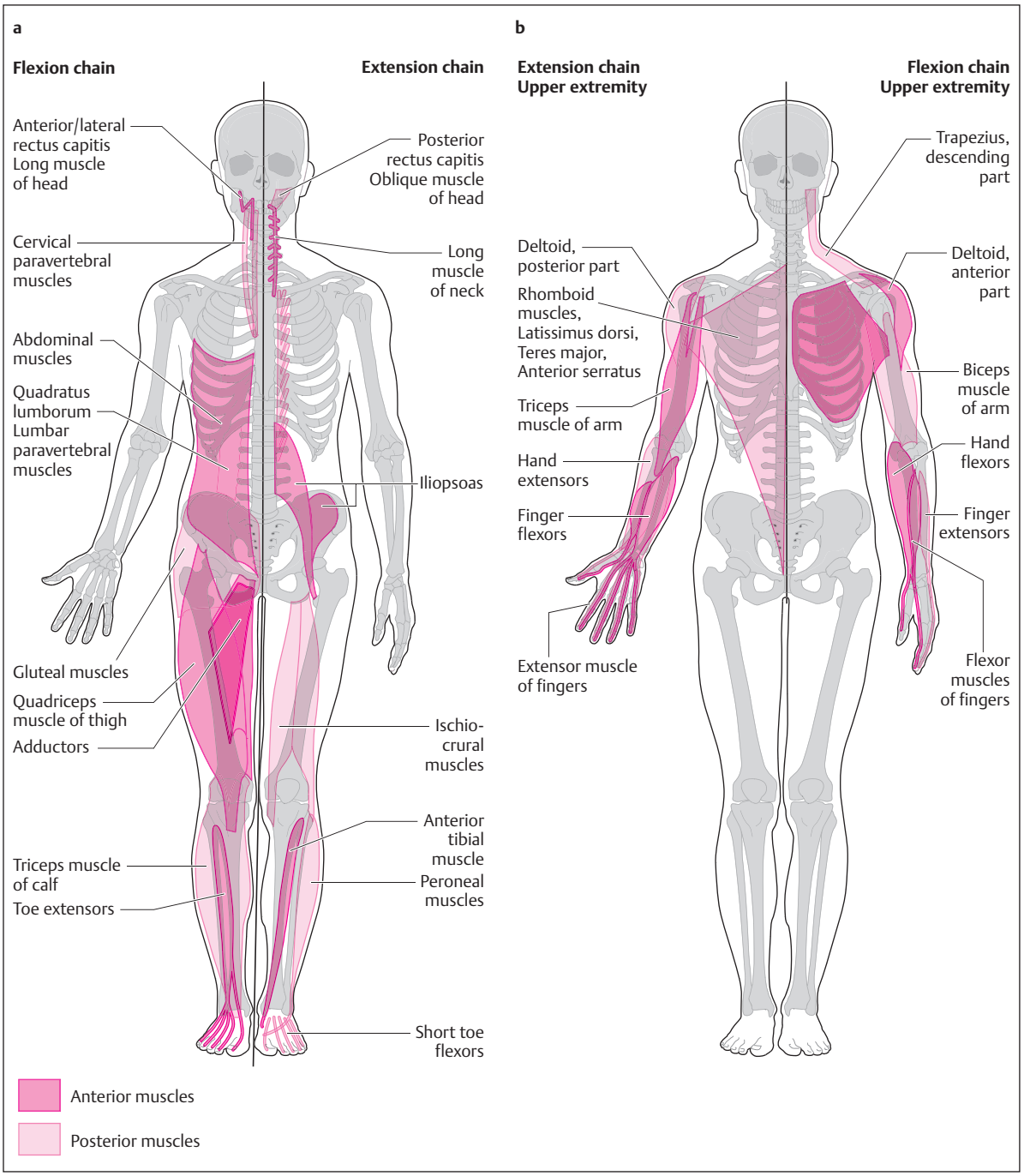
  Note: The thoracolumbar fascia also participates in this mechanism. Its deep layer provides attachment for the multifidus muscles and the quadratus lumborum.



▶ **Fig. 8.4** Anterior view: flexion chain (*right half of body*) and extension chain (*left half of body*). Posterior view: flexion chain (*right half of body*) and extension chain (*left half of body*).

Lower Extremity

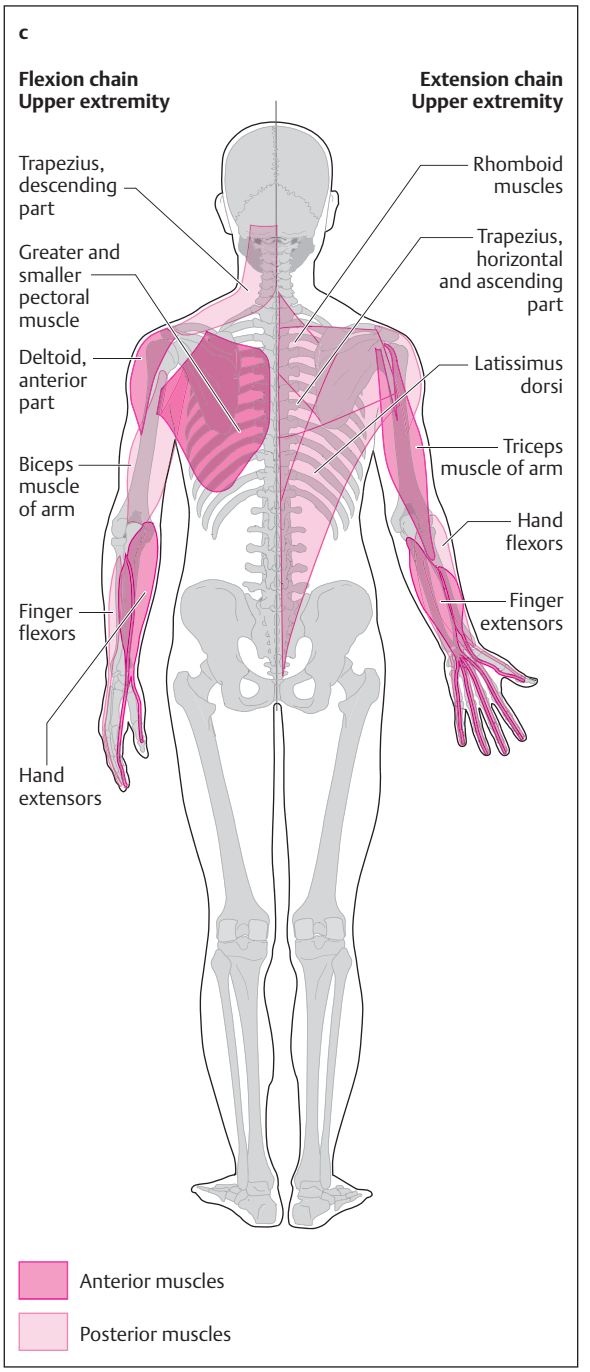
- **Ilium:** The ilium rotates posteriorly while being simultaneously pulled by the abdominal and gluteal muscles.
  Responsible muscles: abdominal muscles, gluteal muscles, and tensor fasciae latae.
- **Hip:** The hip is extended.
  - Responsible muscles: gluteal muscles.
    Note: There is a continuous chain between the abdominal and gluteal muscles via the iliac crest on one side and the thoracolumbar fascia with the quadratus lumborum and the gluteal muscles on the other side. For the gluteal muscles to rotate the iliac posteriorly, they need secure support from the femur. This is provided by two mechanisms:
  - The gluteus maximus connects with the tensor fasciae latae via the iliotibial tract. The tensor fasciae latae prevents external rotation of the hip. This allows the gluteus maximus to apply traction to the ilium.
    The deep layer of the gluteus maximus connects with the vastus lateralis, which is activated by the same motion pattern. Traction from the vastus lateralis provides additional stabilization to the gluteus maximus.



▶ **Fig. 8.5 (a, b)** Anterior view: flexion chain right and extension chain left. **(b)** Anterior view: extension chain of upper extremity right and flexion chain of upper extremity left.

– The posterior rotation of the ilium raises the ramus of pubis and stretches the adductors. The adductors will reclaim their lost length at the other end, at the femur. Posterior rotation of the ilium pulls the leg adductors into adduction and internal rotation. This creates the following position for the lower extremities: **extension + adduction + internal rotation**.

- **Knee:** The knee is extended.
  Responsible muscles: quadriceps muscle of thigh.
- **Upper ankle joint:** The upper ankle joint is in plantar flexion. The talus is pushed forward between



▶ **Fig. 8.5 (c)** Posterior view: extension chain of upper extremity right and flexion chain of upper extremity left.

the ankle fork (mortise formed by the lateral and medial malleolus) and the calcaneus.
Responsible muscles: triceps muscle of calf and flexors.

- **Lower ankle joint and foot:** Dominance of the flexion chain results in eversion of the foot and lowering of the foot arches. The talus plays the main role in this process. Since it does not have muscle insertions, pressure coming from the ankle fork pushes it medially forward. This shifts the weight to the inner edge of the foot. The cuboid bone rotates externally and the navicular bone rotates internally. Responsible muscles: long flexor muscle of toes, anterior tibial muscle, long extensor muscle of great toe, and long extensor muscle of toes.

Upper Extremity

- **Shoulder blade:** The shoulder blade is in abduction; the glenoid cavity of scapula is oriented forward and outward. This presents as rolled in (hunched) shoulders (Janda's upper crossed syndrome). Responsible muscles: descending part of trapezius and smaller pectoral muscle.
  Depending on which muscle traction dominates, the shoulder is either depressed or raised.
- **Upper arm:** The arm is in adduction–internal rotation and extension. The greater pectoral muscle is placed in traction because the thorax is in the expiration position. The muscle reclaims its lost length by moving the arm into adduction–internal rotation. The anterior shoulder tenses the latissimus dorsi. The latissimus dorsi attempts to regain its normal length by extending the shoulder.
  Responsible muscles: greater pectoral muscle, latissimus dorsi, teres major, and subscapular muscle.
- **Lower arm:** The elbow is flexed and the lower arm is pronated.
  Responsible muscles: biceps muscle of arm, brachial muscle, pronator muscles.
- **Hand:** The wrist is in extension.
  Responsible muscles: hand extensors.
- **Fingers:** The fingers are flexed.
  Responsible muscles: finger flexors.
  In this case, we find a reversal of flexion and extension as well as a predominance of the extension–adduction–internal rotation component. However, unlike the lower extremities, which exhibit global extension, this area exhibits flexion behavior. We think this is a vestige of archaic reflexes, such as can be found in spastic hemiplegia.

Extension Chain

Extension chains (▶**Figs. 8.2, 8.3, 8.4, 8.5**) are found together with a cranial flexion pattern.

Cranium

- Occipital bone anterior.
- SBS high.
- Sphenoid: body high.
- Greater wing of sphenoid bone anterior and lateral.
- Peripheral cranium bones in external rotation.

Spine

- **OAA:** Occiput is in extension.
  Atlas is relatively posterior.
  Responsible muscles: major and minor rectus capitis posterior, inferior and superior oblique muscle of head, and sternocleidomastoid (SCM).
  Note: The descending part of the trapezius can move the occiput into extension. Its main function, however, is focused on the shoulder.
- **C3–T4:** Cervical spine is in extension.
  Responsible muscles: long muscle of neck (longus colli).
- **T4–T12:** Thoracic spine is extended.
  Responsible muscles: thoracic paravertebral muscles, superior and inferior posterior serratus muscles, and thoracic fascia.
  Note: Extending the thoracic spine places the thorax into the inspiration position. This is made possible by reciprocal inhibition of the abdominal muscles. It places the diaphragm in its uppermost position, where it can function optimally.
- **T12–L5:** Lumbar spine lordosis is decreased.
  Responsible muscles: iliopsoas.
- **Sacrum:** The sacrum performs a counternutation. Its base moves backward and the coccyx moves forward.
  Responsible muscles: pelvic floor muscles.
  Note: This raises the pelvic floor and improves its function.

Lower Extremity

- **Ilium:** In the sacroiliac joint (SIJ), the ilium rotates anteriorly.
  Responsible muscles: iliopsoas, sartorius, rectus femoris, and adductors.
- **Hip:** The hip is flexed.
  Responsible muscles: rectus femoris, sartorius, adductors (except great adductor), and iliopsoas.
  Note: Anterior ilium rotation and hip flexion stretch the gluteus maximus. This muscle compensates by increasing abduction and external rotation.
  The piriform muscle helps rotate the sacrum toward posterior and at the same time rotates the thigh externally. This results in flexion, external rotation, and abduction of the leg. This fits with the cranial flexion model described by Sutherland.
- **Knee:** The knee is flexed.
  Responsible muscles: ischiocrural muscles (hamstrings).
  The anterior rotation of the coccyx shifts the ischial tuberosity toward posterior. This places tension on the ischiocrural muscles, which can be reduced by knee flexion.
  Note: In the standing position, knee flexion is often inconspicuous. The knee is frequently in recurvation. This is due to the relative relaxation of the sacrotuberal ligaments created by counter-rotation of the ilium and sacrum. This causes the entire pelvis to acquire a tendency toward anteversion. The body balances itself by shifting the buttocks backward. Such patients present with “false hyperlordosis.” The lower lumbar spine is in flexion and the lower thoracic spine compensates by going into lordosis. Typical examples are pregnant women and potbellied men.
- **Upper ankle joint:** The foot is in posterior extension. The talus is pushed backward between the ankle fork and the calcaneus.
  Responsible muscles: anterior tibial muscle, posterior extensor muscles of the toes.
- **Lower ankle joint:** The foot goes into inversion. The plantar muscles of the foot increase the arches of foot. Toes are flexed. Depending on which flexors dominate, this can result in hammer or claw toes.
  Responsible muscles: flexors, peroneal muscles, and posterior tibial muscle.

Upper Extremity

- **Shoulder blade:** The shoulder blade is in adduction and rests on top of the ribs. The shoulder is pulled back and the glenoid cavity of the scapula is oriented toward lateral.
  Responsible muscles: trapezius, rhomboid muscles, and anterior serratus.
  Note: The thorax is in inspiration position and the thoracic spine is in extension. Both contribute to this presentation.
- **Upper arm:** The arm is flexed or less extended than in the flexion pattern.
  Responsible muscles: clavicular part of the greater pectoral muscle, deltoid, and coracobrachial muscle.
  Note: If the shoulder is stabilized toward posterior by the shoulder blade fixators, the smaller and greater pectoral muscles help pull up the ribs. The latissimus dorsi is relatively relaxed due to the posterior positioning of the shoulder. This allows the greater pectoral muscle together with the anterior part of the deltoid and coracobrachial muscle to pull the arm forward. The orientation of the glenoid cavity toward lateral places the arm into external rotation. If the deltoid adds some abduction, it results in the following position: flexion–abduction–external rotation.
- **Lower arm:** The elbow is extended and the lower arm is supinated.
  Responsible muscles: triceps muscle of arm, supinator, and brachioradial muscle.
- **Hand:** The wrist is flexed (or less extended).
  Responsible muscles: hand and finger flexors.
- **Fingers:** The fingers are extended.
  Responsible muscles: finger extensors.