MUSCLE BALANCE: OPPOSING MUSCLES

The following is a brief outline of muscles that oppose each other or work in combination with others in anteroposterior, lateral, and rotary movements and positions of the trunk and lower extremities. The muscles are grouped according to action or the main ones in the action are named.

FOOT

Anteroposterior: Dorsiflexors oppose plantar flexors.

Lateral and rotary: Tibials oppose peroneals.

KNEE

Anteroposterior: Hamstrings, Gastrocnemius, and Popliteus oppose Quadriceps.

HIP

Anteroposterior: Iliopsoas, Rectus femoris, Tensor fasciae latae, and Sartorius oppose Gluteus maximus and Hamstrings.

Lateral: Unilaterally, abductors oppose adductors. Bilaterally, right abductors and left adductors oppose left abductors and right adductors.

Rotary: Unilaterally, internal rotators oppose external rotators. Bilaterally, right internal rotators and left external rotators oppose left internal and right external rotators.

TRUNK

Anteroposterior: Low back muscles oppose anterior abdominal muscles.

Lateral: Lateral trunk muscles oppose each other.

Rotary: Muscles that produce clockwise rotation oppose those that produce counterclockwise rotation.

PELVIS

With the pelvis pivoting in the femora, the opposing groups of muscles act not only in straight anteroposterior opposition, but combine their pulls diagonally to tilt the pelvis forward or backward and laterally.

There are four main groups of muscles in *anteroposterior opposition.*

1. Erector spinae, Quadratus lumborum, and other posterior back muscles attached to the posterior superior part of the pelvis, exert an *upward pull posteriorly.*

2. The anterior abdominals, especially the Rectus abdominis with its insertion on the symphysis pubis and the External oblique with attachment on the anterior iliac crest, exert an *upward pull anteriorly.*

3. The Gluteus maximus and Hamstrings, with attachments on the posterior ilium, sacrum, and ischium, exert a *downward pull posteriorly.*

4. The hip flexors, including the Rectus femoris, Tensor fasciae latae, and Sartorius with attachments on the anterior superior and inferior spines of the ilium, and the Iliopsoas with attachment on the lumbar spine and inner surface of the ilium, *exert a downward pull anteriorly.*

The low back muscles act with the hip flexors (especially the Psoas with its direct pull from the lumbar spine to the femur) to tilt the pelvis down and forward (anterior tilt). They are opposed in action by the combined pull of the anterior abdominals pulling up anteriorly, and the Hamstrings and Gluteus maximus pulling down posteriorly to level the pelvis from a *position of anterior tilt.*

There are two main groups in *lateral opposition*:

1. Leg abductors (mainly the Gluteus minimus and medius), which arise from the lateral surface of the pelvis, pull down on the pelvis when the leg is fixed as in standing.

2. Lateral trunk muscles, attached to the lateral crest of the ilium, pull up laterally on the pelvis.

Hip abductors on one side and lateral trunk muscles on the other side combine in action to tilt the pelvis laterally; right abductors pull *downward* on the right side of the pelvis as left lateral trunk muscles pull *upward* on the left side, and vice versa. These actions are assisted by hip adductors on the same side as the lateral trunk muscles.

In combination, right hip abductors, left hip adductors and left lateral trunk muscles *oppose* left hip abductors, right hip adductors and right lateral trunk muscles.

MUSCLE BALANCE: OPPOSING MUSCLES CONT'D

PRINCIPLES

Posture is a composite of the positions of all the joints of the body at any given moment, and static postural alignment is best described in terms of the positions of the various joints and body segments. The two preceding chapters have provided basic information on anatomical positions, axes, planes, movements of joints, and tests of muscle length. This information is essential when analyzing postural alignment.

Posture may be described, also, in terms of muscle balance. This chapter describes the muscle balance or imbalance associated with static postural positions.

Evaluating and treating postural problems requires an understanding of Basic Principles relating to alignment, joints, and muscles:

- Faulty alignment results in undue stress and strain on bones, joints, ligaments, and muscles.
- An assessment of joint positions indicates which muscles are in an elongated and which are in a shortened position.
- A correlation exists between alignment and muscle test findings if posture is habitual.
- Muscle weakness allows separation of the parts to which the muscle is attached.
- Muscle shortness holds the parts to which the muscle is attached closer together.
- Stretch weakness can occur in one-joint muscles that remain in an elongated condition.
- Adaptive shortening can develop in muscles that remain in a shortened condition.

THE STANDARD POSTURE

As is true in all testing, there must be a standard when evaluating postural alignment. The ideal skeletal alignment used as a standard is consistent with sound scientific principles, involves a minimal amount of stress and strain, and is conducive to maximal efficiency of the body. It is essential that the standard meets these requirements of the whole system of posture training that is built around it is to be sound. Basmajian states "...among mammals, man has the most economical of antigravity mechanisms once the upright posture is attained. The expenditure of muscular energy for what seems to be a most awkward position is actually economical" (27).

In the **standard posture**, the spine presents the normal curves, and the bones of the lower extremities are in ideal alignment for weight bearing. The "neutral" position of the pelvis is conducive to good alignment of the abdomen and trunk, and that of the extremities below. The chest and upper back are in a position that favors optimal function of the respiratory organs. The head is erect in a well-balanced position that minimizes stress on the neck musculature.

The body contour in the illustrations of the standard posture shows the relationship of skeletal structures to surface outline in ideal alignment. There are variations in body type and size, and shape and proportions of the body are factors in weight distribution. Variations in contour are correlated to some degree with variations in skeletal alignment. This is essentially true regardless of body build. An experienced observer can estimate the position of the skeletal structures by observing the contours of the body.

The intersection of the sagittal and coronal midplanes of the body forms a line that is analogous to the **gravity line**. Around this line, the body is hypothetically in a position of equilibrium. Such a position implies a balanced distribution of weight, and a stable position of each joint.

When viewing a posture in standing, a **plumb line** is used to represent a line of reference. A plumb line is a cord with a plumb bob attached to provide an absolute vertical line – standard for measuring deviations. The point in line with which a plumb line is suspended must be a standard **fixed point**. Since the only fixed point in the standing posture is at the base where the feet are in contact with the floor, the point of reference must be at the base. A movable point is not acceptable as a standard. The position of the head is not stationary and using the lobe of the ear as a point in line with which to suspend a plumb line is not appropriate.

In *lateral view*, the fixed reference point is slightly anterior to the outer maleolus and represents the base point of the mid-coronal plane of the body in ideal alignment. In *posterior view*, the point is midway between the heels and represents the base point of the midsagittal plane of the body in ideal alignment.

The standing position may be regarded as the composite alignment of a subject from four views: front, back, right side, and left side. It involves the position and alignment of many joints and parts of the body. It is not expected that any individual should match the standard in every respect, nor have the authors seen anyone who has.

The standard posture is illustrated in front, back, and side views by line drawings and photographs. In *back view*, the line of reference in the drawings and the plumb line in the photographs represent a projection of the gravity line in the midsagittal plane. Beginning midway between the heels, it extends upward midway between the lower extremities, through the midline of the pelvis, spine, sternum, and skull.

MUSCLE BALANCE: OPPOSING MUSCLES CONT'D

For the hip and knee, extension is limited. Ligamentous structures, strong muscles, and tendons are the restraining force preventing hyperextension. Stability in the standing position is obtained by this normal limitation of joint motion.

There should be careful scrutiny of exercises or manipulations that tend to hyperextend the knee or hip joint, or that excessively stretch such muscles as Hamstrings. The normal restraining influence of the ligaments and muscles helps to maintain good postural alignment with a minimum of muscular effort. When muscles and ligaments fail to offer adequate support, the joints exceed their normal range and posture becomes faulty with respect to positions of knee and hip hyperextension. *(See pp. 85, 95, and 96 of Muscles, Testing and Function.)*

Ankle

The line of reference passes slightly anterior to the outer malleolus, and approximately through the apex of the arch, designated laterally by the calcaneocuboid joint. Dorsiflexion at the ankle with the knee extended is normally about 10°. This means that standing barefoot with feet in a position of slight out-toeing and with knees straight, the lower leg cannot sway forward on the foot more than about 10°. Forward deviation of the body (dorsiflexion at the ankle) is checked by the restraining tension of strong posterior muscles and ligaments. However, this element of restraint is materially altered with changes in heel height that place the ankle in varying degrees of plantar flexion, and appreciably altered if the knees are flexed.

Feet

In the standard posture, the position of the feet is one in which the heels are separated about three inches, and the forepart of the feet separated so that the angle of out-toeing is about 8° to 10° from the midline on each side, making a total of 20° or less.

This position of the feet refers only to the static and barefoot position. Elevation of the heels and motion affect the foot position.

In establishing a standard position of the feet, and determining where, if at all, out-toeing should occur, it is necessary to consider the foot in relation to the rest of the lower extremity. The out-toeing position cannot occur at the knee because there is no rotation or extension.

In ideal alignment, the axis of the extended knee joint is in a frontal plane. With the knee joint in this plane, out-toeing cannot take place from the hip joint level. There can be a position of out-toeing as a result of outward rotation of the hip, but the entire extremity would be outwardly rotated and the degree of out-toeing would be exaggerated.

This makes the question of whether there should be rotation of the foot into an out-toeing position dependent on the relationship of the foot to the ankle joint. The ankle joint permits flexion and extension only, no rotation. Unlike the knee joint, the ankle joint is not in a frontal plane. According to anatomists, it is in a slightly oblique plane. The line of obliquity is such that it extends from slightly anterior at the medial malleolus to slightly posterior at the lateral malleolus. The angle at which the axis of the ankle joint deviates from the frontal plane suggests that the foot is normally in a position of slight out-toeing in relation to the lower leg.

The foot is not a rigid structure. The movements of the subtalar and transverse tarsal joints permit pronation and supination of the foot and abduction and adduction of the forefoot. The combination of pronation and forefoot abduction is seen as *eversion* of the foot, and the combination of supination and forefoot adduction as *inversion. (See p. 22 of Muscles, Testing and Function.)* Passive or active movements of the foot and ankle reveal that the foot tends to move *outward as it moves upward, and inward as it moves downward.*

In the standing position, the foot usually is not fully dorsiflexed on the leg nor is it in full eversion. However, the person who stands with flexed knees and marked out-toeing of the feet will be in dorsiflexion and eversion – a position that results in stress and strain on the foot.

It is not possible to determine the degree of eversion or inversion of the foot that corresponds with each degree of dorsal or plantar flexion. The two are not so correlated that an exact relationship exists, but it may be assumed that the movement from eversion in the dorsiflexed position to inversion in the plantar flexed position is relatively uniform.

When influenced by shoes with heels, the standing position represents varying degrees of plantar flexion of the foot based on the heel height. As heel height is increased, the tendency toward a parallel position or in-toeing increases.

The relationship of heel height to out-toeing or in-toeing of the foot in standing, walking, and running. In barefoot standing, a slight degree of out-toeing is natural. Standing with heels raised or walking fast, the feet tend to become parallel. As speed increases from walking to sprinting, the heels do not contact the ground, and the weight is borne on the anterior part of the foot entirely. There is then a tendency for the print of the forefoot to show in-toeing.

MUSCLE BALANCE: OPPOSING MUSCLES CONT'D

Head and Neck

The position of the head and neck in ideal alignment is one in which the head is in a well-balanced position and maintained with minimal muscular effort. In side view, the line of reference coincides with the lobe of the ear and the neck presents the normal anterior curve. In posterior view, the line of reference coincides with the midline of the head and with the cervical spinous processes. The head is not tilted upward nor downward, it is not tilted sideways nor rotated, and the chin is not retracted.

Good alignment of the upper back is essential to good alignment of the head and neck; faulty alignment of the upper back adversely affects the head and neck position. If the upper back slumps into a rounded position in sitting or standing, there will be a compensatory change in the position of the head and neck.

If the head position were to remain fixed with the neck held in its normal anterior curve as the upper back flexed into a position of round upper back, the head would be inclined forward and downward. But "eyes seek eye level" and the head must be raised from that position by extending the cervical spine. In normal extension of the cervical spine, there is an approximation of the occiput and the seventh cervical vertebra. As the head is raised to seek eye level, the distance between the occiput and the seventh cervical vertebra is reduced remarkably. Compared to the separation between the two points in ideal alignment, there may be as much as 2 or 3 inches difference between the two positions.

The forward head position is one in which the neck extensors are in a shortened position and strong, and the potential exists for the development of adaptive shortening in these muscles. The anterior vertebral neck flexors are in an elongated position and give evidence of weakness when tested for strength. *(See below and x-rays on pp. 66 and 91 of Muscles, Testing and Function.)*

Thoracic Spine

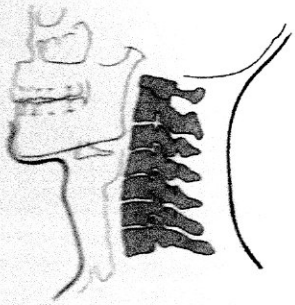
In ideal alignment, the thoracic spine curves slightly in a posterior direction. Just as the positions of the head and neck are affected by the positions of the thoracic spine, so the thoracic spine is affected by the positions of the low back and pelvis. With the pelvis and lumbar spine in ideal alignment, the thoracic spine can assume ideal position. If a normally flexible individual assumes a position of lordosis of the low back (i.e., increased anterior curve), the upper back tends to straighten, decreasing the normal posterior curve. On the other hand, habitual positions and repetitive activities may give rise to the development of a kyphosis-lordosis posture in which one tends to compensate for the other. In a sway-back posture, the position of increased posterior curvature of the upper back compensates for a forward deviation of the pelvis.

Shoulder Joint and Shoulder Girdle

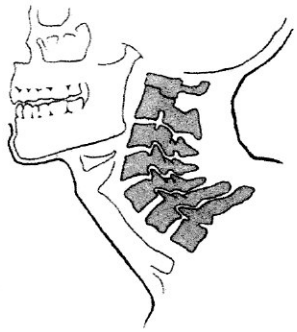
In ideal alignment of the shoulder joint, the side-view line of reference passes midway through the joint. But the position of the arm and shoulder joint depends upon the position of the scapula. In good alignment, the scapulae lie flat against the upper back, approximately between the second and seventh thoracic vertebrae, and about 4 inches apart (more or less, depending upon the size of the individual). Faulty positions of the scapulae adversely affect the position of the shoulder joint, and malalignment of this joint can predispose to injury and chronic pain.

A drawing of the standard posture appears on the following pages. Legends indicate the skeletal structures that coincide with the line of reference. For comparison, beside the drawing is a photograph showing a subject whose alignment closely approaches that of the standard posture.

In the side-view drawing of the standard posture, the artist has attempted to present a composite of male and female pelves, and to show an average in regard to shape, length of sacrum, coccyx, and other measurements.

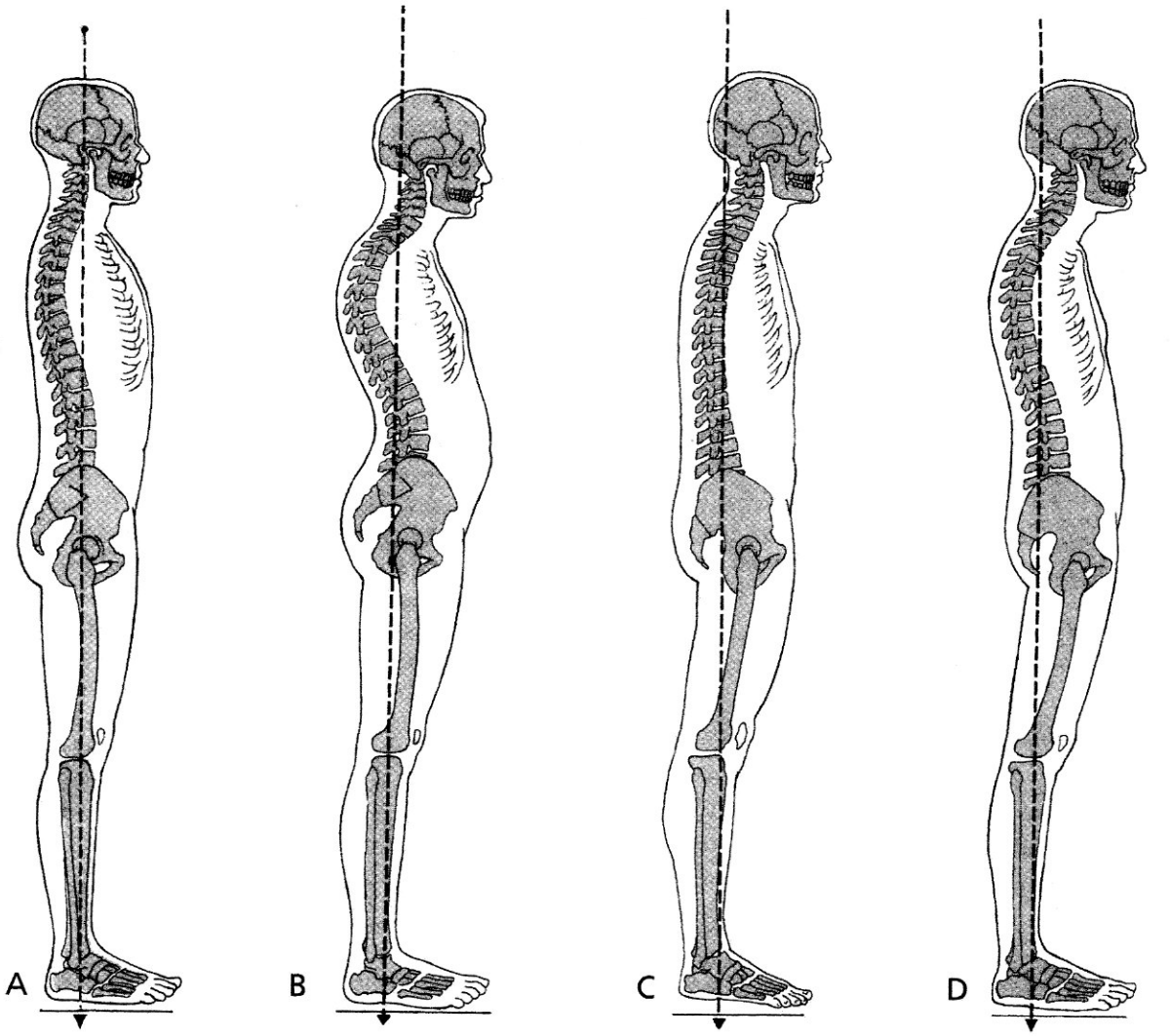


Good alignment of cervical spine.



Extension of cervical spine in faulty posture with round upper back and forward head.

FOUR TYPES OF POSTURAL ALIGNMENT



IDEAL ALIGNMENT | KYPHOSIS-LORDOSIS POSTURE | FLAT-BACK POSTURE | SWAY-BACK POSTURE

The *normal curves of the spine* consist of a curve convex forward in the neck (cervical region), convex backward in the upper back (thoracic region), and convex forward in the low back (lumbar region). These may be described as slight extension of the neck, slight flexion of the upper back, and slight extension of the low back. When there is a normal curve in the low back *the pelvis is in a neutral position*. In Figure A, the bony prominences at the front of the pelvis are in the same vertical plane indicating that the pelvis is in a neutral position.

In faulty postural position, the pelvis may be in anterior, posterior, or lateral tilt. Any tilting of the pelvis involves simultaneous movements of the low back and hip joints. In *anterior pelvic tilt*, Figure B, the pelvis tilts forward decreasing the angle between the pelvis and the thigh anteriorly, resulting in flexion of the hip joint; the low back arches forward creating an increased forward curve (lordosis) in the low back. In *posterior pelvic tilt*, Figure C and D, the pelvis tilts backward, the hip joint extends and the low back flattens. In *lateral pelvic tilt*, one hip is higher than the other and the spine curves with convexity toward the low side. *(For lateral pelvic tilt, see p. 89, 90, 126, and 222-224 of Muscles, Testing and Function.)*