7 COMMUNICATION METHODS OF DEALING WITH INTROVERTED ADOLESCENTS WITH POSTURAL DEFECTS IN GENERAL

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7.1 Posture

According to the Posture Committee of the American Academy of Orthopaedic Surgeons, posture is defined as the balanced and proper alignment of skeletal elements to protect the body from deformations and prevent injury. Posture is an active process that includes perception, emotions and the environment in addition to the coordinated movement of the joint and muscular structures (Dunk & Callaghan, 2010) In other words, posture generally refers to the relationship between the parts of the human body in an upright position. The arrangement of body parts such as the head, neck, trunk, upper and lower extremities constitute posture, and for a good body posture, it should be ergonomically advantageous when standing, mechanically effective when moving and supportive for the normal function of internal organs.

In an anatomical position, a standing person has three main planes:

- Sagittal plane,
- Frontal plane and
- Horizontal plane.

Flexion-extension, dorsiflexion-plantar flexion, forward and backward bending movements are performed in the sagittal plane. In the frontal plane, abduction-adduction, lateral flexion, ulnar-radial deviation, inversion and eversion movements take place. In the horizontal plane, internal-external rotation and axial rotation movements are performed. Understanding these planes and movements is important for the understanding of spinal mobility. The cervical, thoracic and lumbar parts of the spine perform flexion-extension in the sagittal plane, lateral flexion in the frontal plane and axial rotation in the horizontal plane.

When analysing joint movements in our body, we encounter three basic arthrokinetic movements: rolling, sliding and rotation. In addition to these movements, forces or loads can cause stretching, compression, bending, shearing, torsion and combined loading in the

musculoskeletal system. It should not be forgotten that the spine also has parallel osteokinetic movements.

When we look at the muscle groups and their interactions that govern the basic movements of the spine and our posture, the trunk-back muscles, core and stabiliser muscles come to the fore. Muscle activations occur in three types: isometric, concentric and eccentric and ensure correct joint movements. Correct muscle functions and interactions allow for proper movement and correct postural alignment. Body posture is defined in three reference planes, sagittal, coronal and transversal, and is divided into inactive and active posture. Processes that minimize muscle activity such as rest and sleep are defined as inactive posture, while processes that require integrated and coordinated movement of many muscles are defined as active posture. Active posture is also classified as static posture and dynamic posture. Static posture is defined as the posture in which the muscles contract to stabilize the joints, no movement occurs, and the existing position is maintained, and it can be exemplified as the posture in situations such as standing and sitting. Dynamic posture is defined as a posture that requires the function of muscles and joints to form the basis of any movement and consists of non-stationary positions such as walking, running, throwing (O'Sullivan et al., 2002; Claus et al., 2009).

According to a proposed definition of good or correct posture; "Good posture is a state of musculoskeletal balance that protects the supporting structures of the body against injury or progressive deformity, regardless of whether these structures are working or resting. Under these conditions, the muscles work most efficiently, and the internal organs are in optimal positions." (Kendall et al., 2005).

Maintaining correct posture involves minimal stress to the body through the maintenance of musculoskeletal balance. Body posture is a psychomotor habit related to factors such as somatic development, body composition and structure, and its importance for health is often emphasized by its influence on the organization and function of systems and internal organs (Wilczyński & Baran, 2019). Correct posture, characterized by the proper alignment of the cervical, thoracic and lumbar parts of the spine, allows these regions to maintain their anatomically normal curvature (Jorgić et al., 2024). In order to shape the posture, the appropriate mechanisms to resist gravity must work in coordination. Correct posture is an integrated system of osteoarticular, and fascial-ligamentous-muscular structures controlled by the central nervous system to provide optimal conditions for development and puberty (Calloni et al., 2017). Any deviation is defined as bad posture, causing a departure from the ideal posture and triggering stress on the spine (Bullock-Saxton, 1993). Bad posture is associated with reduced gait and functional performance in addition to balance problems. Research in older adults emphasizes that bad posture is associated with increased mortality rates (Page, 2005). When the concept of "bad posture" is examined in the literature, it is concluded that the concept is specific and subjective to the individual and is related to certain postural habits and pain. It is stated that posture may vary from person to person and a posture that may be considered good posture for one person may not be functional or comfortable for another (Barrett et al., 2016; Slater et al., 2019). In this context, when evaluating the concept of posture,

it should be taken into consideration that posture is individualized, and the definition of ideal posture may vary from person to person.

7.2 Relation of Fascia-Muscle-Posture

Fascia is a 3-dimensional connective tissue that extends uninterruptedly throughout the body and surrounds, supports, and separates each tissue (Findley & Shalwala, 2013; Bordoni & Zanier, 2015). Fascia, which wraps the entire body like a taut web, is a dull, colorless anatomical tissue that covers all fibrous collagenous connective tissues (Schleip & Müller, 2013). In the human body, it is known that this structure is in communication with other structures, forms various layers at different depths, and continues uninterruptedly. Therefore, it is an organ that can affect the general health of the individual (Tozzi, 2012). The fascial system, which is closely related to posture, surrounds and intertwines organs, muscle, bone, and nerve fibers, giving the body a functional structure. It ensures the integrated functioning of all body systems (Van Der Wal, 2009).

A review found that although there is strong experimental support for the existence of a superficial posterior line, a posterior functional line and an anterior functional line, the evidence for a spiral line, anterior line and lateral line is weak (Wilke et al., 2016). Although the desired level of evidence for the existence of fascial systems has not been reached in the literature, fascial connections often guide treatments in the clinic and are associated with muscle function and postural problems.

7.2.1 Superficial Back Line

The “Superficial Back Line (SBL)” consists of two sections from the fingers to the knees and from the knees to the forehead. The SBL protects the entire back surface of the body by unifying it like a shield. The overall postural function of the SBL is to support the body in full extension and prevent the tendency to go into flexion. The Achilles tendon, sacrotuberous ligament, thoracolumbar fascia, erector spinae and occipital process are part of the SBL. Unlike other joints, the knees flex under the influence of the SBL muscles. In standing, the tendons of the SBL support the line of stance between the tibia and femur (Figure 1).

Figure 1 Myers, T. W. (2001). Anatomy trains: myofascial meridians for manual and movement therapists.

To stretch the SBL, the trunk can be tilted forwards without bending the knees or, sitting on your knees, the trunk can be tilted forwards until the head touches the floor (Figure 2):

Figure 2 SBL stretch

7.2.2 Superficial Front Line

The Superficial Front Line (SFL) “connects the entire front surface of the body from the top of the feet to the side of the skull in two parts. The overall postural function of the SFL is to provide the support needed to stabilize and lift parts of the skeleton (pubis, rib cage and face) in front of the gravity line. The SFL muscles protect the internal organs by supporting the anterior surface of the human body (soft and sensitive areas). The SFL fuses with the SBL through the periosteum around the phalanx tips. In terms of posture, the dorsiflexors limit excessive backward movement of the tibia-fibula complex, while the plantar flexors prevent excessive forward movement. The sagittal postural balance in the body (A-P balance) is maintained by the free or tight relationship between these two lines. When considered as parts of fascial

planes rather than muscle chains, it is known that in most cases the SFL tends to shift downward and, in response, the SBL tends to shift upward (Figure 3).

Figure 3 Myers, T. W. (2001). Anatomy trains: myofascial meridians for manual and movement therapists.

To stretch the SFL, the knight position can be taken with one knee in front and the trunk can be extended backwards with the arms or the trunk can be lifted upwards in the prone position with support from the hands (Figure 4):

Figure 4 SFL stretch

7.2.3 Lateral Line

The Lateral Line (LL) covers both sides of the body, starting at the midpoints of the feet and lateral midpoints, following the lateral surface of the leg and thigh from the outside of the ankle, and extending to the skull. The general postural function of the LL is to balance the front and back as well as the left and right sides. The LL also regulates the forces between the other superficial lines. The LL stabilizes the trunk and legs during any activity involving the arms (Figure 5).

Figure 5 Myers, T. W. (2001). Anatomy trains: myofascial meridians for manual and movement therapists.

To stretch the LL, one can sit with one knee bent and the other leg extended to the side, with one hand on the extended leg and the other hand on the head, the trunk can be extended sideways and upwards. Alternatively, stretching is performed by reaching upwards with the arm in a side-lying position with support from one hand and the side edge of the feet (Figure 6):

Figure 6 LL stretch

7.2.4 Spiral Line

The Spiral Line (SPL) forms a spiral structure around the body, starting from the upper back, through the shoulder and around the ribs to the buttocks. The Spiral Line passes under the anterolateral part of the thigh and under the arch of the foot and runs along the back of the leg towards the ischium and erector fascia, ending very close to where it started. The postural function of the SPL is to provide postural balance in all planes by spiralling the body. The SPL helps the knee to move in a controlled manner during walking by connecting the arch of the foot with the pelvic tilt. The SPL plays a role in creating, coordinating and maintaining rotational movements in the body in balance disorders. Many myofascial components in the SPL are connected to other fascial lines and can affect their proper functioning and functionality (Picture 7).

Figure 7 Myers, T. W. (2001). Anatomy trains: myofascial meridians for manual and movement therapists.

To stretch the SPL, you can sit with one knee bent and the other leg extended, support from the floor with one arm and apply resistance with the other arm with the elbow bent. Alternatively, in a kneeling position with one knee bent and the other leg extended backwards, stretching can be done forward with the help of body weight with the hands (Figure 8):

Figure 8 SPL stretch

7.2.5 Arm Lines

The four different myofascial lines associated with the axial skeleton and extending to the arm are defined as the Arm Lines. It is a myofascial line with multiple cross connections within itself in order to control and stabilize the variability due to the high mobility of the shoulder and arm. The postural function of the arm lines is to create a tension line extending from the elbow to the back. It can influence the position of the shoulders, neck, rib cage and ribs, creating resistance to respiratory function. It is activated in activities such as weight transfer and push-ups on the arms (Figure 9).

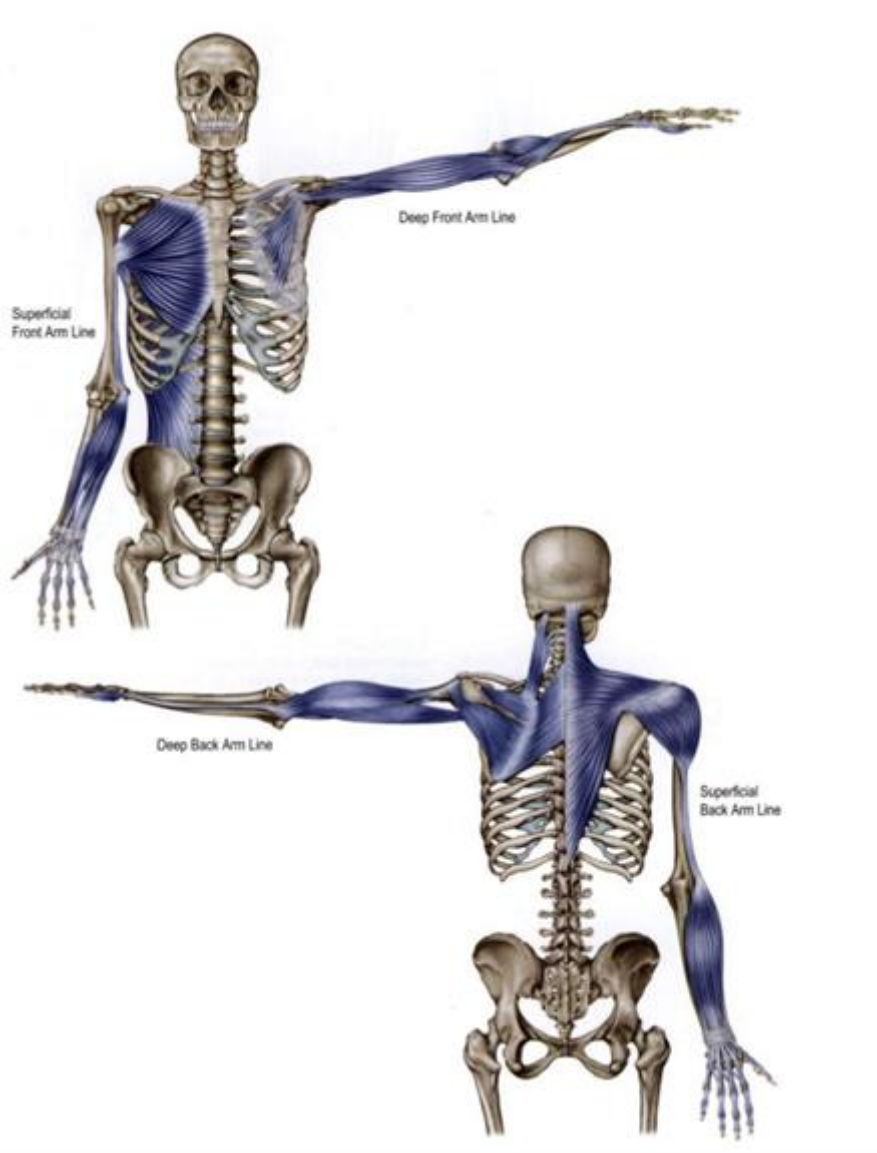


Figure 9 Myers, T. W. (2001). Anatomy trains: myofascial meridians for manual and movement therapists.

To stretch the Arm Lines, you can try sitting with one hand extended behind the torso from above, trying to connect the fingers with the other hand extending from the waist. Alternatively, while standing on one leg, the arms can be crossed over each other for a stretching effect (Figure 10):

Figure 10 Arm Lines stretch

7.2.6 Functional Lines

“Functional Lines”, which extend from the arm lines to the opposite pelvis and leg, are rarely used to change postural position. They are mainly involved in activities that require stabilization and balance. For example, during javelin or baseball throwing, they provide force dissipation by stabilizing the opposite side of the throwing limb (Figure 11).

Figure 11 Myers, T. W. (2001). Anatomy trains: myofascial meridians for manual and movement therapists.

7.2.7 Deep Front Line

The “Deep Front Line (DFL)”, which forms the myofascial core of the body, is located between the left and right Lateral Lines in the coronal plane and between the Superficial Front Line and the Superficial Posterior Line in the sagittal plane and is surrounded by the Spiral and Functional Lines. It starts deep in the sole of the foot and extends along the back of the knee to the inner thigh. From this point it continues upwards through the hip joint, pelvis and lumbar spine to the skull. Compared to the previous outlines, the DFL is considered three-dimensional. The DFL includes the supporting muscles, regulates the respiratory period and gait rhythm, provides balance between the internal organs and acts as a stabilizer between the other lines. The postural functions of the DFL support the body by elevating the medial arch, stabilizing the lower extremities, supporting the lumbar spine from the front, providing rib cage mobility during inspiration and expiration, and balancing the head and neck. In summary, DFL reduces the work done by the muscles to maintain a balanced posture and keep the body in an upright position (Figure 12) (Myers, 2009).

Figure 12 Myers, T. W. (2001). Anatomy trains: myofascial meridians for manual and movement therapists

To stretch the DFL, with one knee in front and the other leg extended backwards, the body weight can be transferred forwards by inversion or eversion of the foot (Figure 13):

Figure 13 DFL stretch

Coordinated activation of muscles is required to maintain and sustain posture. When general muscle activations are examined using electromyography:

- The intrinsic muscles of the foot are immobilized due to the support provided by the ligaments.
- Soleus is constantly active against gravity, while gastrocnemius, tibialis posterior and tibialis anterior muscles are relatively less active.
- The quadriceps and hamstring muscles are minimally active.
- Iliopsoas is constantly active.
- Gluteus maximus is not active.

- Gluteus medius and tensor fascia lata muscles are active to prevent lateral postural oscillation.
- The erector spinae muscles are active to counteract gravity.
- The lower fibers of the deep obliques are active to protect the abdomen while the superficial abdominal muscles are inactive (Tikkanen et al., 2013; Chiba et al., 2016).

7.3 Posture in Adolescence

Adolescence is the transition period from childhood to adulthood during which physical growth, sexual development and psychosocial maturation take place and is one of the most important stages of human development. Adolescents may face some psychosocial problems specific to this period, such as being in the process of identity formation, accelerated cognitive development, increased emotional intensity, career choice, establishing a relationship with the opposite sex, separation from parents and individualization. In this period when psychosocial problems and risk-taking behaviors are more common than in other periods of life, protecting and improving the health of adolescents, preventing risky behaviors that may negatively affect their lives and well-being, strengthening their abilities, and increasing their skills and capacity in combating these behaviors are of great importance in protecting and improving both the physical and psychosocial health of adolescents (Sharma & Rawat, 2023).

In addition to developing self-image and self-esteem, gaining the ability to manage emotions and relationships, and increasing qualities and abilities, body posture is also physiologically formed during adolescence. Body posture can be influenced by a wide range of physiological, occupational and biomechanical factors. In order to prevent the emergence of postural problems and their negative effects in daily life, it is of great importance to be able to predict the factors affecting posture and their consequences. Postural defects affect not only the adolescent himself/herself but also his/her environment and play an important role in defining the social personality of the individual. Since postural problems are frequently seen in childhood and adolescence, it is necessary to emphasize the importance of protective and preventive programs in this period. Therefore, from the earliest possible childhood period, in addition to increasing the level of physical activity and adopting a healthy lifestyle, the habit of developing and maintaining the correct posture should be tried to be gained. (Sharma & Rawat, 2023), In this context, cooperation between health institutions, pre-school and school institutions, sports clubs and families is of great importance in the education system. Raising awareness of the family on issues such as healthy living habits and the importance of regular physical activity is of great importance in terms of preventing all kinds of diseases. It is emphasized that physical activity can benefit from the contributions of physical activity such as supporting the development process positively, correcting posture disorders and deformities and developing positive motor skills by training parents to direct and motivate their children to participate in different types of physical activity (Protić-Gava, 2014).

Especially in spinal disorders that progress to the point of treatment, cooperation between family, teachers and health professionals becomes much more important and requires joint decision-making to achieve treatment goals. Considering that living with postural defects is a critical psychosocial factor for body image and identity development in adolescents, psychological and social aspects should be examined in addition to the physical condition during the evaluation process. Conducting all these evaluations by a multidisciplinary team in cooperation with the adolescent and the family facilitates obtaining more useful and faster results. If the primary goal is to establish healthy and effective communication with the adolescent throughout the whole process, to include them in the decision-making process and to ensure their active participation in the treatment, General health can be improved.

(Sebastian et al., 2008; Van Leijenhorst et al., 2010).

7.4 Postural Defects

Posture is defined as the optimal positioning of each part of the body in relation to the neighbouring part and the whole body. When we look from the sagittal plane, the vertebral column shows anatomical curvatures along the segments and these curvatures allow us to determine the neutral position for each segment. There are normal curvatures called lordosis in the cervical and lumbar segments of the spine and kyphosis in the thoracic and sacral segments, and abnormalities in these curvatures cause problems in postural alignment (Figure 14) (Czaprowski et al., 2018).

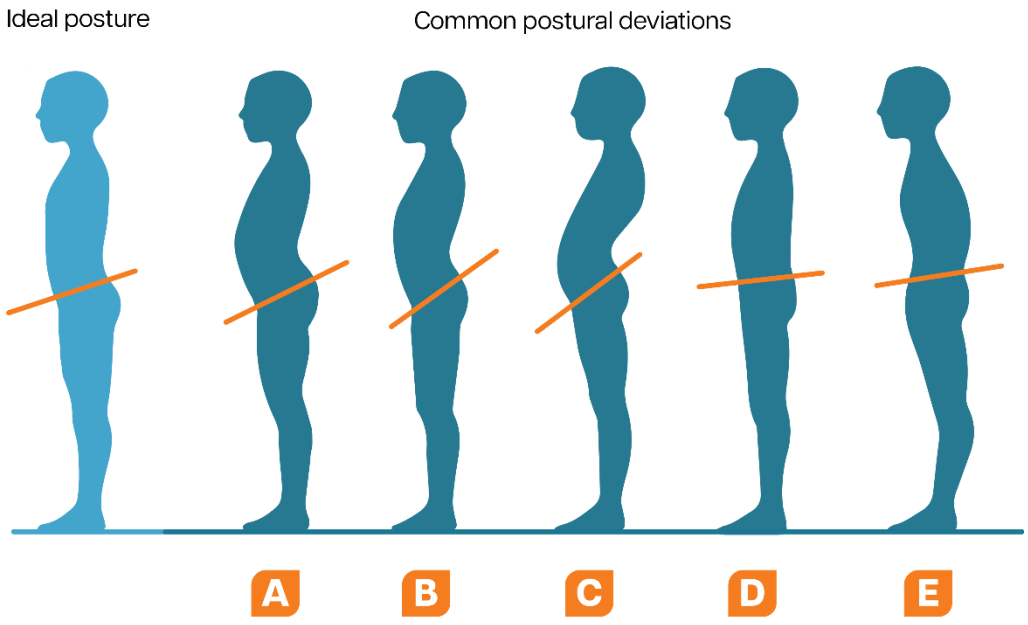


Figure 14 Myers, T. W. (2001). Anatomy trains: myofascial meridians for manual and movement therapists (90).

In children and adolescents, morphological changes related to skeletal growth and maturation of the postural control centre alter spinal alignment to improve spinal balance. The alignment of the spine can be disturbed due to deformities, musculoskeletal problems and neurodegenerative lesions. Spinal misalignment requires a precise analysis that distinguishes between structural disorders, transient changes and compensatory mechanisms. Precise knowledge of normal alignment is needed to guide therapeutic decision-making to restore a balanced alignment (Abelin-Genevois, 2021).

Since posture is provided by the interaction of multiple factors, the formation of postural problems can develop due to many reasons including physical, environmental, sociocultural and psychological.

Age, gender, genetic factors, inactive lifestyle can be counted among the physical causes of postural problems. In addition to genetic determinants, interactions between the nervous and endocrine systems can also cause developmental problems and deformations by affecting posture (Dayer et al., 2013).

The body structure, body composition and physical activity level of the person also affect posture indirectly. Today, obesity, which is frequently encountered especially in childhood, is emphasised as an important factor. Obesity and low level of physical activity trigger each other and cause overloading of the musculoskeletal system and development of inappropriate posture patterns in the process of posture development. In this context, these factors can be changed positively by modifications such as providing the necessary conditions and environmental arrangement to encourage physical activity, reducing screen time by ensuring that people spend their free time in quality, gaining healthy eating habits, organising school bags and working environment (Vincent & McKernan, 2013).

In a study examining the relationship between body composition and postural defects in school-age children, correct spinal alignment was found in only 41% of the children evaluated, while different problems such as decreased and/or increased lordosis, decreased and/or increased kyphosis and scoliosis were observed in the rest. In the study in which significant correlations were found between body composition and posture, it was reported that the curvatures in the spine were smooth in children with mesomorph type strong body structure, whereas alignment problems were more likely to be seen in children with ectomorph type weak body structure. No correlation was found with body composition in children with scoliosis or scoliotic posture. In the light of these findings, it is stated that unilateral and single-system therapeutic approaches should be avoided in the prevention and correction of postural problems and approaches that take into account both somatic and neurophysiological factors are appropriate. In addition, it is emphasised that it is much easier to shape the correct posture habit with the correct body composition/structure (Wilczyński et al., 2020).

In a recent study conducted to investigate the occurrence of back and side view posture defects in school-age children and to determine the risk factors associated with the occurrence of posture abnormalities, it was observed that the body posture of the children examined was closed, head pushed forward and drooping, shoulders rounded, hyperlordosis and pelvic

anteversion. In most of the children, various abnormalities related to the feet were detected and this was considered as a bad sign for the future as it may cause further asymmetry. Only some of the postural abnormalities identified were significantly associated with the risk factors studied, such as age (older children), gender (more common in boys), BMI (overweight/obesity), desk sitting (no adjustable chair), time spent on the computer (two hours or more) and dietary habits (snacks between meals) (Baranowska et al., 2023).

As a result of the sociocultural changes brought about by the Internet age, postural defects are encountered more frequently. With the increase in the use of online courses and technological devices brought about by the Covid-19 pandemic, adolescents have become more isolated from their families and social life. In addition to long-term screen use, factors such as the family's wrong attitude towards this situation and the inability to provide adequate physical and mental support increase and facilitate the development of postural problems in adolescents. For adolescents who are at a sensitive stage in every sense, conditions such as loss of self-confidence, aesthetic and cosmetic problems, negative body image, loneliness and depressive mood brought by postural problems have a great impact on adolescents by reducing psychological resilience and social commitment (Endo et al., 2012; Parrish et al., 2018; In et al., 2021).

Postural problems that develop due to multiple causes include changes in existing kyphotic and lordotic curvatures or decreases and/or increases. Postural defects mainly affect the musculoskeletal system and may cause functional impairment and tension in supporting structures. As a result of muscle weakness and shortness due to impairment in the stabilisation function of the muscles, decrease or increase in muscle activation, imbalance and functional loss occur between mobilizing and stabilizing muscles. Posture can be evaluated from anterior, posterior and lateral directions and defects occurring in the sagittal plane are more prominent. Common postural defects include forward-head posture, kyphotic posture, kypholordotic posture, sway-back posture, flat-back posture and scoliosis (Griegel-Morris et al., 1992).

7.4.1 Forward Head Posture

Forward Head posture is a posture in which the head is shifted forwards with the chin protruding. It is caused by increased flexion of the lower cervical spine and upper thoracic spine and increased extension of the upper cervical spine and occiput. FHP is considered one of the most common musculoskeletal abnormalities, characterised by incorrect posture of the head in the sagittal plane and a tilt of the body's centre of gravity more forward than a vertical line relative to the head position. This causes increased load and biomechanical stress on the cervical joints and ligamentous system (Lee et al., 2022). Numerous studies have identified several causes and risk factors for FHP, including repetitive and cumulative traumas to the neck, prolonged sitting, improper head position during work, and smartphone use (Kim & Koo, 2023). Several conditions related to FHP, including thoracic kyphosis and cervical range of motion, postural control, muscle weakness, pain and injury, can lead to neck pain, headaches, migraines and postural abnormalities (Mahmoud et al., 2019).

7.4.2 Kyphotic Posture

Kyphosis is defined as a physiological curvature of the spine in the sagittal plane with posterior convexity. According to the Scoliosis Research Society, the thoracic curvature in the sagittal plane should be between 20° and 45° Cobb degrees in growing adolescents and young adults. Hyperkyphosis is an angle of kyphosis that exceeds the normal range and may present as a structural or postural disorder. Hyperkyphosis can occur at any level of the thoracic or lumbar spine but is most likely in the main thoracic region or at the thoracolumbar junction (Tribus, 1998; Miladi 2013).

Scheuermann's kyphosis is referred to as idiopathic kyphosis, representing a rigid deformity that occurs due to compression of the thoracic vertebrae and endplate irregularities during spinal growth. Increased kyphosis in the thoracic region can cause pain, breathing difficulties and cosmetic problems. In addition, kyphotic posture is associated with back pain and poor cosmetic appearance. In addition, health-related quality of life (HRQoL) is lower in patients with kyphosis compared to healthy controls (Kamali et al., 2016; Zapata et al., 2021).

7.4.3 Kypholordotic Posture

In this posture, the head is in anterior tilt, cervical vertebrae are in hyperextension position, scapula is in abduction, dorsal and lumbar lordosis is increased, pelvis is in anterior pelvic tilt, hip is in flexion, knee is slightly hyperextended, ankle is slightly plantar flexed. Muscle groups are also affected due to this posture. Neck extensors, hip flexors, lumbar extensors are shortened and strengthened. Neck flexors and upper thoracic extensor oblique muscles are weak and extended. Hamstrings are extended but may not be weak (Kendall et al., 2005).

7.4.4 Lordotic Posture

Lordosis refers to the forward curvature of the spine. Exaggeration of this curve is usually referred to as hyper-lordosis. The head, neck and thoracic spine are in neutral position. The lumbar spine is hyperextended, causing an anterior tilt of the pelvis. The hips are flexed, the knees are hyperextended, and the ankles are in plantar flexion. In lordotic posture, the headline descends behind the lumbar vertebral bodies, passing close to the intervertebral facet joints, which causes extensor overload of the facets. The head line also lies in front of the axis of the knee joint, leading to overload of the anterior knee compartment. The headline may overlap the baseline or cross in front of it in anterior head tilt. The abdominal muscles are extended and weak. The lower back muscles and hip flexors are short and strong (Kendall et al., 2005; Czaprowski et al., 2018).

7.4.5 Sway-back Posture

In this type of posture, there is an anteriror tilt of the head, straightening of the cervical and lumbar spine, flexion of the thoracic spine, posterior tilt of the pelvis, hyperextension of the hip and knee, and slight plantar flexion of the ankle. In the sway back posture, the anterior pelvic tilt and thoracic kyphosis are flattened to the upper part of the lumbar spine.

The pelvis is in front of the headline, while the upper part of the trunk is usually orientated behind this axis. The headline and the base line usually overlap each other, which ensures the normal position of the head. However, the head is protruded due to the inclination of the chest in relation to the base and the headline. The headline passes posteriorly to the lumbar vertebral bodies (causing extension overload) and posteriorly to the axis of the hip joints (causing hip joint overload). The neck flexors, middle/lower trapezius, thoracic paraspinals, external obliques and iliopsoas are extended and weak. Hip extensors are short and strong (Kendall et al., 2005).

7.4.6 Flat-back Posture

In this type of posture, the head is in anterior tilt with the cervical spine. There is a slight flexion of the upper thoracic spine and extension of the lower thoracic and lumbar spine. The pelvis is in posterior tilt, knees in extension and ankles in plantar flexion. In the flat back posture, the headline and baseline usually overlap and pass in front of the lumbar vertebral bodies (leading to flexion overload) and behind the hip joint axis. The hip flexors are extended and weak. The hip extensors are short and strong (Kendall et al., 2005).

7.4.7 Upper Cross Syndrome

Upper cross syndrome (UCS) is also called proximal or shoulder girdle cross syndrome. UCS is defined as ‘tightness of the upper trapezius, pectoralis major and levator scapula muscles and weakness of the serratus anterior, middle and lower trapezius and deep neck flexors, especially the scalene muscles. UCS can cause body dysfunctions such as headache, early fatigue and decreased respiratory capacity. UCS is associated with deep neck flexor weakness and muscle imbalances of key antagonists, including strong pectoral muscles and sternocleidomastoid, leading to an increase in thoracic kyphosis, cervical lordosis and FHP. Individuals presenting with upper cross syndrome have a forward head posture as well as altered shoulder girdle function, elliptical shoulders, scapular winging and decreased mobility of the thoracic spine (Ardhadi et al., 2019).

7.4.8 Lower Cross Syndrome

Lower Cross Syndrome (LCS) is a common disorder characterized by muscle tension caused by an imbalance in the strength of muscles in the lower limbs, and it has also been reported that LCS is a musculoskeletal imbalance characterized by specific patterns of muscle

weakness, also known as pelvic. LCS results from an imbalance of muscle strength in the lower limbs, affected by muscle tension on the iliopsoas, rectus femoris, tensor fascia lata, adductor group, gastrocnemius, and soleus. Due to muscle imbalance, the person with LCS may develop low back pain later in life. This muscle imbalance causes joint pain (low back, hip and knee) and specific postural changes such as anterior pelvic tilt, lumbar lordosis, lateral lumbar shift, external rotation of the hip and knee hyperextension. It can also lead to increased thoracic kyphosis and cervical lordosis. There are two known subtypes of lower cross syndrome (A and B). The two types are similar and involve the same main muscle imbalance characteristics. In type A, the imbalance occurs in the hip, while in type B the imbalance occurs in the lower back. The two subgroups can be distinguished according to altered postural alignment and regional patterns of myofascial activation (Ngang Naga et al., 2021).

7.4.9 Scoliosis

Scoliosis is a complex three-dimensional structural deformity accompanied by lateral deviation of the spine over 10°, axial rotation and sagittal plane deviations on coronal spine radiography. Each of these components contributes to the general shape and structure of the spine in individuals with scoliosis. When we consider scoliosis in the sagittal plane, this plane is very important for understanding the overall balance of the spine and its effect on posture and function. Scoliosis is defined using the Cobb angle in the coronal plane of the spine, often accompanied by vertebral rotation in the transverse plane and hypokyphosis in the sagittal plane. These abnormalities in the costovertebral joints, vertebral rotation and thorax produce a ‘convex’ and ‘concave’ haemithorax. When the scoliosis becomes more pronounced, the rotational component begins and leads to torsion-scoliosis, also known as hunchback (Newton et al., 2015, Burkus et al., 2018).

The following symptoms may suggest scoliosis:

- Lateral curvature of the spine
- Trunk lateral flexion
- Change in shoulder heights
- Differences in pelvic height
- Leg length inequalities
- Muscle pain
- Ligament and tendon pain
- Decreased respiratory function

There are several different types affecting children and adolescents. Currently, the most common type is “Adolescent Idiopathic Scoliosis (AIS)”. AIS usually develops between the ages of 10 and 18 years, between the onset of puberty and the closure of the growth plate, and its prevalence is reported to be 2-3% (Diebo et al., 2019; Weinstein et al., 2008; Yılmaz et al., 2020; Burwell et al., 2016).

7.5 Evaluation of Postural Defects

Correction of postural defects, which aims to restore proper sagittal alignment, should start with a detailed clinical examination, and continue with the application of specific exercises aimed at restoring the function of the musculoskeletal system. Although diagnostic evaluations for postural problems include modern imaging techniques such as digital whole-body radiography, computed tomography or nuclear magnetic resonance, basic clinical examination and anamnesis remain valuable (Czaprowski et al., 2018).

The main objective of posture analysis, which is frequently used by physiotherapists in clinical examination, is to determine the postural defects in individuals, to apply the correct treatment programme and to prevent postural problems that may occur in the future. Auxiliary tools such as plurimeters, inclinometers and goniometers can often be used in physiotherapy and rehabilitation assessments for posture analysis. Posture analysis is performed from lateral, anterior and posterior directions and examined in detail in terms of head-neck position, shoulder heights, thoracic cage alignment, symmetry of lumbar hollows, pelvic tilt, hip levels, leg length inequalities, knee and foot alignments. In addition to posture tables (New York Posture Rating Scale, Bragg) and length-distance measurements, methods such as Picturegraphy in sagittal plane, symmetrygraphy and radiography are used in posture analysis. In addition to posture analysis, range of motion, flexibility, muscle strength, balance, respiration, pain and quality of life should be evaluated. Shortened and/or extended muscle groups should be identified and hypoactive or hyperactive structures that have lost their function should be detected. Spinal flexibility and range of motion are greatly affected due to muscular imbalance. Considering that respiratory functions may be affected due to changes in spine and rib cage alignment, pulmonary function tests and respiratory muscle strength should be evaluated. Since the change in spinal alignment will cause changes in gravity and centre of gravity, postural control may be adversely affected, and this may cause balance problems and should be included in the evaluation programme. The evaluation of the concept of posture, which is formed because of the interaction of multiple systems, should be made in a holistic manner to address all systems and the treatment programme should be shaped in the light of these evaluations (Figure 15) (Rahman et al., 2017).

Figure 15 Posture analysis is performed from lateral, anterior and posterior directions

The gold standard for the diagnosis and evaluation of spinal deformities is radiographic imaging of the trunk. As a result of the reflection of X-rays on the spine, the Cobb method is used to measure and categorise curvatures. With the increase in computer-aided approaches to determine the Cobb angle, more consistent and reliable results are obtained. Despite all these advantages, the radiation and long-term adverse effects of radiographic methods are an important point to be considered (Stecher et al., 2024). In addition to radiation, alternative methods are preferred due to disadvantages such as image distortion and low inter-observer reliability. EOS®, a low-dose dual-plane digital radiographic imaging system, is an example of a current alternative method. Spinopelvic parameters such as thoracic kyphosis, lumbar lordosis, sacral kyphosis and pelvic ratio in EOS® are reliable and comparable to conventional C1-S1 radiographs (Shakeri et al., 2024).

Raster-stereography, Spinal Mouse® spinal scanning systems and Picturegrammetry are the three main non-radiographic methods currently preferred. Raster-stereography allows assessment by using infrared cameras and beams projected onto the person to be measured. Raster-stereography, which offers a wide range of postural parameters and can be used quickly, is a high-cost method. Spinal Mouse® is a valid and reliable tool that can be rolled along the spine, allowing measurement of vertebral shape and angulation, and is frequently used for spinal assessment, especially in cases of increased kyphosis. Picturegrammetry is a low-cost and frequently preferred tool that allows kinematic and geometric analysis of

movement and posture in two-dimensional evaluations. It is also actively used in the process of creating 3D models using Picturegraphs, diagnosing and evaluating posture disorders (Belli et al., 2023).

Spinometry, another radiation-free method, is a three-dimensional tool for spinal imaging that provides additional information about functional gait patterns related to the pelvis and lower extremities. This technology, which uses surface topography to mark bone regions and detect asymmetry, supports the long-term treatment process by helping to evaluate spinal deformities (Bode et al., 2024). Another topographic method, the newly developed torsobarography, enables the detection of sagittal imbalance and asymmetric morphology of the trunk by analyzing the pressure distribution along the trunk in the lying position. Torsobarographs, which are thought to be a pioneering system in the early diagnosis of postural deformities, have an important potential in terms of providing reliable posture analysis (Stecher et al., 2024).

Mobile applications, which are frequently used due to the developing technology and the increase in the use of smart phones, stand out as popular methods used in terms of subjective evaluation of posture and as a supportive tool. Light sensor-based software developed as 3-dimensional mobile scanning tools are rapidly progressing towards becoming highly accessible tools that prevent the progression of postural defects, reduce or correct them with effective treatments, provide feedback to the person (Kandasamy et al., 2023). The Scoliosis Tele Screening Test (STS-Test), one of the mobile applications for posture analysis developed for the use of parents, offers the opportunity to assess the risk of scoliosis. This test, which allows parents to observe and monitor the spine at regular intervals and to detect scoliosis without the need to visit a health institution, supports the active participation of the family in early diagnosis. Developed as a cost-effective, result-oriented, protective and up-to-date method, this test is a good alternative method with validity and reliability (Yılmaz et al., 2023).

In Adolescent Idiopathic Scoliosis (AIS), which is the most common spinal deformity in adolescence, it is of great importance to detect the deformity to prevent its progression and to perform appropriate interventions. The diagnosis of AIS is made by both clinical examination and specific radiological examinations. Clinical evaluation includes postural and anthropometric analyses. In Adam's Forward Bending Test, which is one of the most used effective and simple clinical tests, the spine is evaluated for the presence of curvature and asymmetry by asking the person to bend forward while standing. While the person is in a comfortable standing position, the posture of the person is evaluated from the anterior, posterior and lateral directions and the shoulder and hip levels, the presence of midline shifts that may develop compensatory in the trunk and pelvis, head-neck asymmetry and deviations in the whole spine alignment are examined. One of the most important points in the clinical evaluation is the anamnesis, and family history, pain status, growth potential, presence of neurological or other symptoms, participation in activities of daily living and physical activity level are questioned.

Radiological evaluation is routinely used in the diagnosis of AIS and Cobb angle calculations are used to detect curvature and determine the type and severity of scoliosis (Scaramuzzo,

2023). In a recent study conducted to determine the Cobb angle; in addition to the prediction ability of the deep learning algorithm used by comparing the measurement results calculated with routine radiological imaging and the imaging system with 3D depth sensors; It was aimed to examine the result measurements depending on the presence or absence of clothing. As a result of the study, it is stated that the predicted Cobb angle results and the actual results are correlated. It is concluded that the method is a valuable alternative for scoliosis examination with underwear since there is no significant difference in the measurement results with and without underwear in the forward bending posture and the psychological burden of naked evaluation cannot be ignored, especially for adolescents (Ishikawa et al., 2023).

When the questionnaires used to evaluate postural problems are analysed; Scoliosis Research Society Questionnaire (SRS-22r) is an internationally widely used questionnaire developed to evaluate health-related quality of life in people with AIS. Validity and reliability studies of the questionnaire have been conducted and current studies suggest that the questionnaire can be revised to increase its scope and improve the outcome measurements. Other frequently used questionnaires include the Spinal Appearance Questionnaire (SAQ), which evaluates personal perception of cosmetic deformity, physical appearance and image, and the Kyphosis Specific Spinal Appearance Questionnaire (KSAQ), which was developed to evaluate the appearance in hyperkyphosis patients (Yağcı et al., 2023; Sanders et al., 2007; Zapata et al., 2021).

7.6 Treatment of Postural Defects

Correct body posture plays a vital role in human health. It is suggested that ideal upright posture is a sign of musculoskeletal health and is one of the main indicators of movement system health (Griegel-Morris et al., 1992). Therefore, defects in posture may adversely affect the health of the person if left untreated. The management of postural problems requires a multidisciplinary approach and requires the use of different components such as exercise training, ergonomic arrangements, orthosis, taping, surgery, psychosocial support.

Although surgical options are considered in cases where posture problems are very severe, treatments generally consist of conventional methods. Supportive methods such as the use of orthosis, plastering, device use is also preferred according to the condition of the person. Since these methods immobilize an isolated part of the body by applying corrective forces, they may have a dysfunctional effect on the muscle (Hrysomallis & Garrison, 2001).

Physiotherapy and exercise training are frequently recommended and used more frequently in the prevention or correction of postural disorders. By acting on the muscle imbalance caused by posture problems with exercises; shortened muscles with increased activity are extended and muscles with prolonged and decreased activity are strengthened (Romano et al., 2012).

Posture is negatively affected, and postural problems become common as a result of the increase in static postural positions such as prolonged sitting with the effect of modern lifestyle, prolonged screen time due to the use of technological devices such as phones and computers, and negative changes in physical activity level (In Jung et al., 2024).

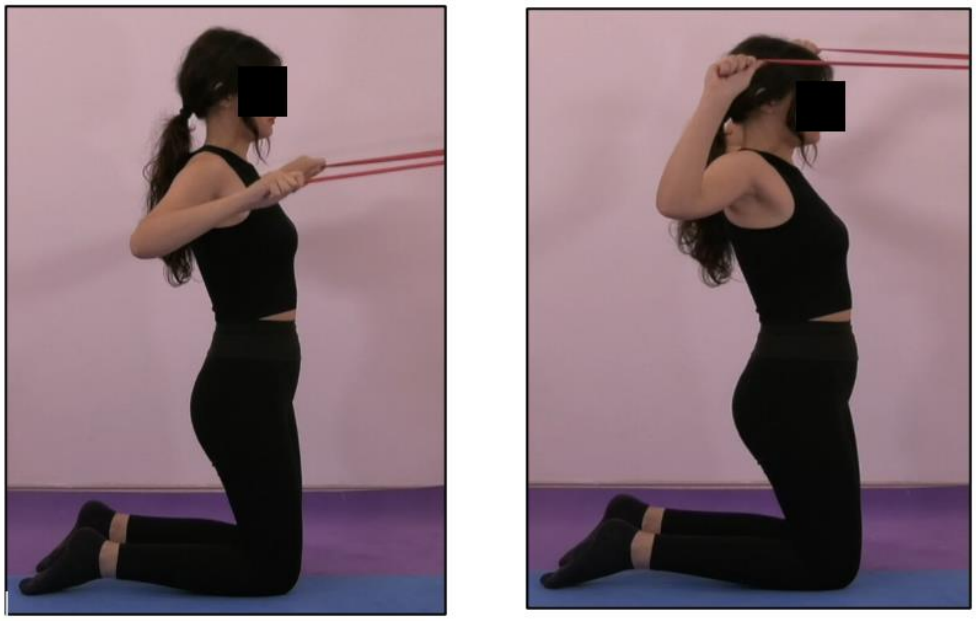
It is recognized that physical activity has important health advantages such as reducing mortality risks, improving psychological well-being and mental health, reducing chronic diseases and maintaining ideal weight. For these reasons, increasing physical activity, which is recognised as a fundamental component of health, is defined as a global health priority. It is thought that posture can be maintained and improved by increasing the level of physical activity (Salsali et al., 2023).

Basically, within the scope of physiotherapy and rehabilitation applications aiming to manage pain, maintain function, maintain and improve alignment; methods such as superficial heat agents, stretching-recovery exercises, aerobic exercises, core stabilization and strengthening exercises, biofeedback, cognitive-behavioral therapy and acupuncture and combinations of these methods with each other are preferred (Haldeman et al., 2018).

The adolescent and family should be included in the decision-making and treatment program planning process. An individualized treatment program suitable for the individual should be created by taking into account the wishes and goals of the adolescent. Family education is very important in terms of the effectiveness and sustainability of the treatment; active participation of the family is necessary in motivating and supporting the adolescent and making ergonomic arrangements suitable for the adolescent.

Posture-correcting exercises are very diverse and include movements for the neck, back, shoulders and pelvic floor. Exercises such as cat-and-mouse, scapular retraction and chin-tuck are frequently used.

Examples of exercises are presented below (Figures 16):



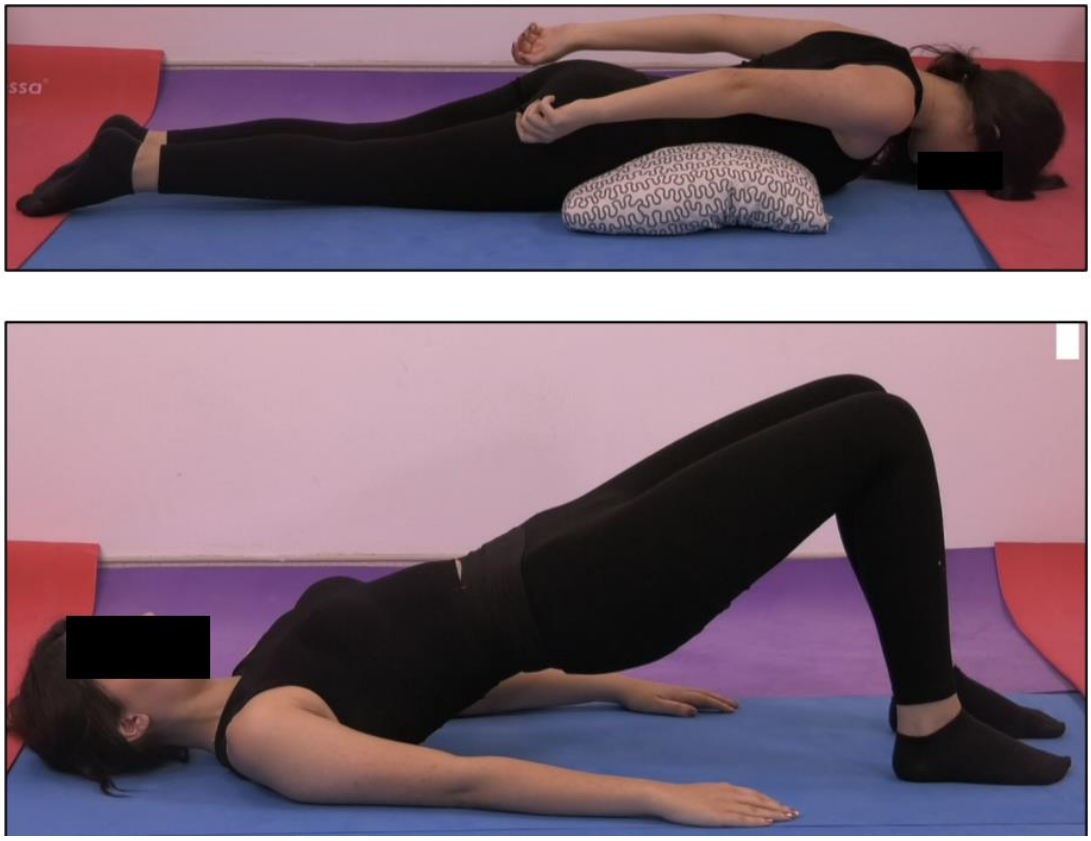


Figure 16 Posture correcting exercise samples

There are a wide variety of exercise methods that can be used, and McKenzie and Williams exercises are the accepted methods preferred especially for back and low back pain. While McKenzie exercises are identified with spinal extension exercises, Williams exercises are identified with lumbar flexion exercises (Faas, 1996).

The Mckenzie method adopts self-healing through posture correction and high-frequency repetitive exercise movements. This method, which was developed for diagnostic purposes as well as treatment, evaluates patients by dividing them into subgroups according to their clinical condition. In this method, which is based on the phenomenon of centralization; pain progressing from the spine to the distal spine returns to the spine with repetitive movements and recovery is aimed with appropriate exercises. Prone and standing lumbar extension exercises are preferred to lengthen the spine (Lam et al., 2018).

The Williams method is used to improve lumbar flexion and strengthen the gluteal and abdominal muscles. Unlike McKenzie exercises, the Williams method, which focuses on lumbar flexion, includes exercises based on posterior pelvic tilt, stretching the hamstrings and hip flexors, squats, single knee and stretching the spine by pulling both knees towards the chest (Fatemi et al., 2015):

1) Pelvic tilt- The posterior pelvic tilt position is performed with the patient lying on their back with their hands at their side and knees bent. The patient is then asked to tighten the abdominal muscles as well as the gluteal muscles and press the back towards the floor.

2) Single knee to chest- The single knee to chest movement is performed with the patient lying on a table or bed. The patient is then asked to release one leg from the table or bed, bend the other leg and wrap the hands around the bent knee and pull the bent leg towards the chest.

3) Double knee to chest- The double knee to chest stretch is also performed with the patient lying on his/her back. The patient is asked to bring both knees to the chest, one at a time. The patient holds his/her hands together, pulls his/her knees towards the chest and tilts his/her head forwards. While performing the movement, the patient is asked to keep the knees together and shoulders flat on the floor. The patient then lowers one leg at a time.

4) Hamstring stretching- The patient lies on his back with his hands at his side. With one knee bent and the other knee straight, he is asked to pull the foot of the straight leg towards him. He is then asked to lift his leg until he feels a stretch in the back of his thigh.

5) Squat- Standing with feet slightly wider than hip width apart, toes pointing slightly outwards, hands are asked to be clasped on the chest for balance. The hips are pushed backwards, and the knees are lowered as low as possible. Arms can be swung backwards for momentum.

6) Hip Flexor Stretch- Kneeling on the affected leg and bending the good leg forwards, with this leg flat on the floor and keeping the back straight, slowly push the hip forwards until you feel a stretch in the upper thigh of the back leg.

When these two methods, which offer different approaches, are compared, McKenzie exercises are preferred in disc problems and in cases where relief is provided with extension, and Williams exercises are preferred in cases worsened by extension. A recent study concluded that McKenzie exercises are more effective in reducing pain and improving functionality (Karez et al., 2023).

Other methods include ergonomic interventions, superficial heat agents, self-myofascial release techniques, soft tissue mobilizations, manual therapy, posture corrective exercises, scapulothoracic stabilization exercises, stretching and strengthening exercises. In the treatment of postural problems; exercises that increase body and mind coordination and improve body awareness should also be included in the program (Chang et al., 2023).

It is stated that Pilates exercises are effective in correcting postural disorders with correct exercise selection and controlled practice. It is emphasized that Pilates, which integrates the use of upper and lower extremities with the trunk instead of training certain muscle groups separately, provides improvement on pain and Cobb angle, strengthens the relevant muscles by correcting postural disorders and alleviates the severity of deformity. There is evidence that Pilates is a popularized method due to its advantages such as being safe, easy to apply and suitable for all ages and can be used to increase spinal mobility, improve quality of life, physical function and health.

(Negrini et al., 2008; Gou et al., 2021; Emery et al., 2010; Alves de Araújo et al., 2012; Li et al., 2024).

In recent years, virtual reality systems have started to be used in evaluation and treatment in the field of rehabilitation. Virtual reality programs offer the opportunity to experience situations that can be encountered in real life in a safe environment by reducing the risks faced by patients (Bryanton et al., 2006; Park et al., 2013).

Therapists need a meaningful and motivational tool to increase the effectiveness of exercises. In this context, game-based virtual reality systems, an innovative technology, are seen as a useful tool in rehabilitation and their use is becoming widespread day by day. In a study investigating the effectiveness of a game-based virtual reality system on Forward-head-posture; it was concluded that it can be used as a facilitating tool for individuals with FHP to perform therapeutic exercises correctly and for physiotherapists to follow up (Asadzadeh, 2024). It was concluded that virtual reality interventions applied in patients with chronic low back pain are effective on physical functions and quality of life. It is expected that the use of these applications in clinical and home environments will increase gradually (Weiss et al., 2004).

The treatment of scoliosis, the most complex deformity of the spine, is multifaceted. The aim of treatment is to prevent progression of the curve, improve aesthetic appearance, reduce asymmetric compression load, eliminate muscle imbalances, prevent asymmetric torsion during walking, increase respiratory function, reduce symptoms that impair quality of life such as pain, and improve balance by providing active and passive correct posture. Skeletal maturation of the patient must be taken into consideration in the treatment of AIS. In patients

with growth potential, follow-up at 6-month intervals for curves less than 25 degrees, conservative treatment for curves between 25-45 degrees and surgical treatment for curves greater than 45 degrees are recommended. In addition to bone maturation, factors such as Cobb angle, age, menarche, gender, type and pattern of curvature are of great importance when deciding on conservative treatment methods (Dimeglio & Canavese, 2013; McLaughlin, 2016).

The treatment recommendations for scoliosis given by the International Society for Scoliosis Orthopedics and Rehabilitation Treatment (SOSORT) are as follows:

-In the first stage of idiopathic scoliosis treatment, scoliosis-specific exercises should be performed to prevent progression of the deformity.

The exercise program should be in accordance with the principles of three-dimensional treatment, training in activities of daily living, maintenance of corrected posture and patient education.

- The exercise program should be planned according to the effectiveness shown in scientific publications.
- The application should be designed by physiotherapists trained in this field.
- Communication within the treatment team is essential.
- Exercises should be individually planned and personalized for each patient.
- For successful results, it is recommended to perform the exercises regularly.

The main exercises used in the treatment of scoliosis are posture exercises, flexibility exercises, respiratory exercises, stretching exercises and strengthening exercises. The exercises are aimed at preventing or reversing the progression of curvature, stopping spinal and thoracic deformities in the long term, preventing respiratory dysfunctions, treating spinal pain syndromes and providing aesthetic and posture correction (Figure 17, 18, 19, 20, 21):

Figure 17 Cat cow exercises

Figure 18 Cat cow exercises

Figure 19 Breathing exercises

Figure 20 Cross arm leg extension exercise

Figure 21 Cross arm leg extension exercise

The most used conservative treatment method for low to moderate curvatures in AIS is the use of orthoses and braces. Orthosis and bracing are disadvantageous methods in terms of muscle atrophy, rigidity and flat-back posture development and require long-term use. Orthosis and bracing are combined with scoliosis-specific exercises (SSE) to reduce the side effects of prolonged immobilization and improve final outcomes. Numerous studies have demonstrated the effectiveness of orthosis and bracing in altering the natural progression of AIS and reducing the likelihood of surgical intervention. The most important factor in the success of orthosis and brace use is the individual's compliance and adherence. In this context, since long-term use of orthosis/corset is required to obtain effective results, it is necessary to accurately monitor how many hours the patient wears the orthosis/corset and to evaluate the actual compliance. Technological developments in recent years have led to the use of electronic devices such as thermal or pressure sensors in braces/orthotics, which overcome the limitations of traditional questionnaires or verbal reports and enable more precise monitoring of treatment compliance (Fregne et al., 2024).

While physical activity and exercise therapy are recommended to patients regardless of orthosis and surgery in AIS, curvature-specific exercise methods have been developed in many different methodologies in the conservative treatment of AIS. Although these methods differ in principle, they have common goals such as preventing the progression of deformity, delaying the use of bracing and improving the functionality of the individual (In Jung et al., 2024).

SSE consists of asymmetric movement groups different from normal exercise groups. In the clinic, SSE is used alone for low-grade curves and in combination with orthotics for moderate curves. For curvatures above a certain degree in adulthood, SSI is the primary treatment. The

mechanical changes it produces on the muscles and soft tissues around the spine and the idea that the neuromotor control of the spine can be reorganized accordingly make SSI an important treatment tool. In addition, it is known to be effective in reducing pain, stabilizing curvature, reducing functional distress, improving cardiopulmonary function and thoracic expansion. When used in combination with a brace/orthotic, SSE contributes to reducing the side effects of the brace/orthotic, increasing mobility and achieving better corection (Berdishevsky et al., 2016).

Three-dimensional exercise approaches developed within the scope of SSE are known as Schroth Approach, Scientific Exercise Approach for Scoliosis (SEAS), Lyon Approach, Barcelona Scoliosis Physical Therapy School (BSPTS), Dobomed Method, Side Shift Method and Functional Individual Treatment of Scoliosis (FITS).

The Schroth method is the most preferred method that offers an evidence-based exercise approach and has been used for many years. In Schroth, in addition to exercise training, posture training is provided, and the person is helped to maintain the correct posture during daily life activities. Schroth exercises basically include asymmetric trunk exercises with rotational breathing. Thus, it provides reorganization of the muscle imbalance that develops due to rotational forces associated with scoliosis. This regulation is realized by the coordination of sensorimotor system and kinesthetic stimuli. It is known that rotational breathing combined with asymmetric exercises is superior to other standard treatments in providing benefits such as reduction in trunk rotation, postural balance, improvement in body image perception, increase in vital capacity and muscle Endurance (Bayraktar et al., 2018; Weiss et al., 2016; Moramarco et al., 2018).

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