Scoliosis and kyphosis

See also the separate Examination of the Spine article.

Spinal deformity rarely occurs in a single plane and is usually in three dimensions. It is often defined as a three-dimensional torsional deformity of the spine and trunk [1] . Combined kyphosis and scoliosis is called kyphoscoliosis.

- **Kyphosis** is excessive curvature of the spine in the sagittal (A-P) plane. The normal back has 20° to 45° of curvature in the upper back, and anything in excess of 45° is called kyphosis.
- **Scoliosis** is abnormal curvature of the spine in the coronal (lateral) plane. Scoliosis of between 10° and 20° is called mild. Less than 10° is postural variation.
- **Lordosis** or hyperlordosis is excessive curving of the lower spine and is often associated with scoliosis or kyphosis. It can be exaggerated by poor posture.

NB: 'structural scoliosis', or just scoliosis, is very different from 'functional scoliosis', which is a spinal curvature secondary to known extra-spinal causes (eg, shortening of a lower limb or paraspinal muscle tone asymmetry). It is usually partially reduced or completely subsides after the underlying cause is eliminated (eg, in a recumbent position). Functional scoliosis is not discussed in this article.

Epidemiology

- The prevalence of these conditions varies considerably according to the precise definition that is used.
- In early childhood about 60% are boys but, in the adolescent variety, girls represent 90%. Adolescent scoliosis, also termed adolescent idiopathic scoliosis (AIS), occurs in around 2-3% of the general population [1] .

- Screening should be directed at girls at the maximum age of incidence. Boys should be screened at a slightly later age but girls outnumber boys by 9 to 1.
- Scoliosis to the right is very much more common than to the left except in the infantile type where a left-sided curve is more common. A right thoracic scoliosis has the thoracic spine convex to the right.

Definitions and staging

- Infantile scoliosis occurs before age 3 and is seen more frequently in boys. Although neurological involvement is possible, many resolve spontaneously but some may progress to severe deformity.
- Juvenile scoliosis is found more frequently in girls between the ages of 3 and 10. These curves are at a high risk for progression and often require surgical intervention.
- AIS occurs between age 10 and maturity. AIS may start at the onset of puberty or become apparent during an adolescent growth spurt. Females are at higher risk, often requiring surgical treatment, if non-operative treatment fails to halt curvature.
- Adult scoliosis occurs after maturity.

Risk factors

- Abnormal curvature of the spine can result from disease of the vertebral column, including trauma or imbalance of the neuromuscular system. It may be congenital. It can be produced by legs of different lengths.
- In adults, kyphosis is often related to osteoporosis but in children it can be due to injury, a tumour on the spine, or a genetic disorder, such as Hunter's syndrome or spina bifida.
- About 80% of scoliosis is idiopathic.

Presentation

Symptoms

- Mild disease is usually painless but, as deformity grows, pain will usually increase.
- Scoliosis in children or adolescents is often detected on routine screening.
- Patients with AIS most often present with unlevel shoulders, waistline asymmetry (one hip 'sticking out' more than the other), or a rib prominence [2] .
- Ask about family history of scoliosis.

Signs

- Physical examination should include a baseline assessment of posture and body contour.
- Inspect the back from behind with the patient standing upright with the whole back bared and the patient wearing no shoes:
    - Note any curvature and difference in muscle mass between the two sides.
    - Often it is helpful to run a finger down the dorsal spines of the vertebral column, as it is easier to feel than to see a curve.
    - Shoulder unlevelling and protruding scapulae are common. The scapula normally protrudes on the convex side.
    - In the most common type (right thoracic), the right shoulder is consistently rotated forward and the medial border of the right scapula protrudes posteriorly.
- Ask the patient to bend forwards (Adam's forward bend test). Note whether the curvature increases or lessens with this manoeuvre. A fixed scoliosis becomes more obvious on flexion.
- A scoliometer is an instrument that is placed on the back and can be used to provide an objective measure of curve rotation [3] .
- Ask the patient to bend sideways. Note the range of movement and if there is lack of symmetry between the two sides. A scoliometer can be used.

- Assessment of tendon reflexes should be performed for all four limbs. Tightness of hamstrings should be assessed. Check for ataxia, poor balance and proprioception.
- The hip normally protrudes on the concave side.
- If there is just a mild scoliosis, try placing a small wedge under one foot:
    - Note whether this improves the condition. If it makes it worse, try the wedge under the other foot.
    - Adjust the size of the wedge to remove the curvature. If this can be achieved, the problem is due to shortening of one leg, and a built-up shoe will correct it.
    - Legs may be shorter after severe trauma with fractures or if there is neuromuscular imbalance before maturity, as with poliomyelitis, but shortening of 1 cm or 2 cm often occurs with no apparent cause.

Types of scoliosis

- Idiopathic (80%). This is not associated with dysmorphic features, skin lesions or neuromuscular disease.
- Congenital malformations of the vertebrae (10%) can cause deformity. These are commonly associated with genitourinary anomalies.
- Neuromuscular conditions (15%) include cerebral palsy, spina bifida and poliomyelitis.
- Metabolic problems such as Hunter's syndrome.
- Crush fracture from trauma, osteoporosis, tuberculosis or malignancy.
- Dysmorphic syndromes such as neurofibromatosis, Marfan's syndrome, osteogenesis imperfecta.

Investigations

- PA and lateral X-rays of the spine. A commonly used parameter is Cobb's angle:
    - To use the Cobb's method of measuring the degree of scoliosis, the most tilted vertebrae above and below the apex of the curve are chosen.
    - The angle between intersecting lines drawn perpendicularly to the top of the top vertebrae and the bottom of the bottom vertebrae is Cobb's angle.
    - As a general rule, a Cobb's angle of 10° is regarded as the minimum angulation to define scoliosis.
- Lateral bending view can assess the degree to which it can be corrected.
- If a radiograph is normal the patient and family can be reassured that there is no scoliosis [2] .
- A radionucleotide bone scan shows the metabolic activity in the bone.
- CT and MRI scanning may be used to assess the spinal canal, the structure of the vertebral column and threat to the spinal cord.
- Depending upon the age of the patient and other findings, other investigations may be indicated.
- Oxygen saturation and forced vital capacity may be necessary for those with more severe deformity [4] .

Associated diseases

- There may be a spinal tumour causing musculoskeletal dysfunction.
- There may be malformations of the nervous system with Arnold-Chiari malformation or syringomyelia.
- Congenital malformations of the vertebrae may sometimes be associated with abnormalities of the kidneys or urinary tract and congenital heart defects.

Management

Management depends upon the type of condition, the severity, the prognosis and the patient's tolerance for various interventions. Early diagnosis and intervention are beneficial. Management may be divided into:

- Observation
- Orthosis
- Operation

The International Scientific Society on Scoliosis Orthopaedic and Rehabilitation Treatment (SOSORT) aims is to offer to all professionals and their patients an evidence-based updated review of the actual evidence on conservative treatment of idiopathic scoliosis [1] .

The aims of comprehensive conservative treatment of idiopathic scoliosis are:

- To stop curve progression at puberty (or possibly even reduce it).
- To prevent or treat respiratory dysfunction.
- To prevent or treat spinal pain syndromes.
- To improve aesthetics via postural correction.

Infantile idiopathic scoliosis

- This has a much better chance of spontaneous recovery than the others, at about 90%. Double curves have a worse prognosis.
- If the condition worsens, the conventional thoracolumbosacral orthosis (TLSO) type of braces or Milwaukee braces can be employed.
- Casts are sometimes used but their value is debated.
- If surgery is required, a balance must be drawn between improving prognosis as the child gets older and bigger and worsening prognosis as the condition deteriorates.

Juvenile idiopathic scoliosis (JIS)

- JIS is very similar to the adolescent version and is often considered to be a more severe type of AIS.
- Approximately 70% of curves in patients with JIS progress and ultimately require surgery [5] .
- Casting and/or bracing can be effective for the management of JIS.

Adolescent idiopathic scoliosis (AIS)

- AIS is the most common type of idiopathic scoliosis and the most common type of scoliosis overall.
- Small curves in more mature patients have a low risk of progression at about 2%.
- Larger curves in more immature patients, have a much higher risk at around 70%.
- Treatment for AIS depends on the extent of the curve.
- A rapid change in the degree of curvature is likely to need bracing or even surgery.

Bracing

- The SOSORT guidelines offer an actual standard of conservative care, including braces, exercises, sports activities and assessment [1] .
- Brace treatment is thought to be effective only in patients who are still growing. The primary goal of bracing for scoliosis is to halt curve progression.
- One Cochrane review concluded that there was insufficient evidence to support the use of braces for idiopathic scoliosis in adolescents [6] .
- A recent prospective cohort study has shown that bracing in patients with AIS is effective in reducing progression and preventing surgery. In addition, combining bracing with exercises has been shown to increase treatment efficacy [7] .

- Brace treatment is not necessarily benign in terms of the psychosocial and body image concerns it causes for many patients and their families [8] .
- Families must be counselled that there is a risk that bracing may not be successful, but that the chances of success are improved with discipline and adherence to wearing the brace for the recommended time, which can be up to 23 hours a day [2] .
- The brace can be removed for washing and swimming.

Exercises

- High-quality evidence is lacking regarding the benefit of exercises [9] .
- One study has shown, however, that active self-correction and task-orientated exercises are superior to traditional exercises in reducing spinal deformities and improving the health-related quality of life in patients with mild AIS [10] .

Surgery

- Around one out of six patients require treatment, of which 25% progress to surgery [11] .
- Surgery is generally indicated to treat a significant clinical deformity or to correct a scoliotic deformity that is likely to progress.
- Surgery is recommended in adolescents with a curve that has a Cobb's angle greater than 45° to 50° [2] .
- The aims of surgery are usually to arrest curve progression by achieving a solid fusion, to correct the deformity and to improve cosmetic appearance.
- MAGnetic Expansion Control (MAGEC®) growth rods can be used in place of current growth rod systems that need repeated invasive surgical procedures. They are usually removed and replaced by a spinal fixation system to fuse the spine when skeletal maturity is reached [12] .

- The National Institute for Health and Care Excellence (NICE) has confirmed that the MAGEC® system is an effective treatment for children with scoliosis for whom surgery is considered necessary [13] . They also concluded that the MAGEC® system is likely to provide benefits compared with the use of conventional growth rods.
- Back pain after surgery is not uncommon, especially if it is mechanical in nature. In the presence of continuous or night pain, infection or non-union should be considered, and referral to a specialist is advised [2] .

Adult idiopathic scoliosis

- This form is likely to be associated with cardiopulmonary problems if the angle exceeds 60° to 65° and with myelopathy if it exceeds 90°.
- They may progress at about 1° a year, even after growth is complete.
- Operative treatment has more complications than with juveniles.
- Orthopaedic surgeons will have different criteria for the various types of deformity and the age and progress of the patient.
- Operative fixation is required if deformity is very marked but at a lesser level if the deformity is rigid.

Postural

- Postural 'round back' is an increase in thoracic kyphosis while standing.
- Curve flexibility is seen when the patient 'stands tall' or, when prone or supine, it disappears.
- This condition is commonly seen in middle school children, especially girls.
- It does not progress and resolves spontaneously.

Scheuermann's disease

- Scheuermann's disease produces a thoracic kyphosis of more than 40° with true structural changes within the thoracic vertebrae with 5° of wedging in each of three adjacent vertebrae measured on side-view films. It is usually painless.

- Observation is enough for angles of less than 60° and brace treatment for curves between 60° and 80° if the patient is skeletally immature. Surgery is rarely required.
- A subtype of Scheuermann's disease occurs in the lumbar spine, usually in males in late adolescence who are involved in heavy lifting. The changes of the vertebra and disc reflect the physical stress effects. Treatment is to eliminate the offending activity. It has a strong familial trend and may be autosomal dominant. Scoliosis also occurs in 25%.

Complications

- Idiopathic scoliosis can cause weakness of respiratory muscles and reduced exercise capacity. The mechanism of these symptoms is still unknown [14] .
- Distortion of the spinal column may cause restriction of the chest with impairment of lung function.
- Compression of abdominal contents can occur.
- Severe deformity may impinge on the spinal cord and cause paraplegia.
- Treatment of scoliosis without recognition of Arnold-Chiari malformation or syringomyelia may result in paraplegia.
- The disease can be associated with psychological problems, especially in adolescents [15] .

Prognosis

- The younger the child and the greater the curvature, the worse the prognosis, with the exception of infantile scoliosis.
- Skeletal maturity is important, as scoliosis can progress during skeletal growth.
- Once a deformity has proved to be progressive, surgical intervention will probably be necessary because orthotic treatment is less effective in these cases.

Prevention

There is little that can be done to prevent scoliosis or kyphosis except that the adult type is often related to osteoporosis, especially the dowager's hump. Prevention of osteoporosis is discussed in the Osteoporosis article.

Further reading

- Scoliosis Association (UK)

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