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DEGENERATIVE SCOLIOSIS – The Silent disability

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Introduction to Scoliosis

Scoliosis is defined as an abnormal lateral and rotational curve of the spine. It is defined as a side-to-side curve in the spine. From the Greek word ‘skoliosis’ meaning “bending” or “crooked” Scoliosis can either have a single curve shaped as a “C” or a dual curve shaped as an “S” The details will be delved into in subsequent sections. In the thoracic spine, it is associated with a rib hump formed due to the cluttering of ribs due to the abnormal curvature. Degenerative scoliosis begins after the age of 40. An early and localised deformity gives rise to isolated joint subluxation which then progresses to a loss of lordosis and eventual sagittal imbalance after affecting the entire spine.

Types of curves

The curves of the spine as mentioned earlier are of 2 main types:

1. The Primary curve

This is the structural deformity curve which is first to develop due to the processes mentioned above. The primary curve is the largest curve. This curve is not correctable with ipsilateral bending. There are also elements of wedging and rotation present complicating the situation and contributing to the instability.

2. The secondary curve

This is a compensatory curve present above and below the primary curve in opposite direction. The secondary curve is an attempt at stabilisation of the spine and normalisation of the sagittal balance by the surrounding normal spine.

Causes

Scoliosis can be caused by a number of pathological conditions:

1. Congenital causes
2. Neuromuscular disorders
3. Degenerative spine
4. Idiopathic

Although idiopathic scoliosis, which is seen in children and young adults presents a greater challenge for correction, we confine ourselves to the topic at hand – Degenerative Scoliosis.

Degenerative scoliosis:

Introduction

Degenerative scoliosis is a result of wear and tear on the discs and joints of the spine. It is the most common type of scoliosis in adults, and usually happens in the lumbar spine. The pathophysiology includes Facet Arthropathy which progresses into instability and eventual deformity. The stages of spinal degeneration include:

1. Facet Arthropathy
2. Degenerative Disc Disease
3. Spinal Arthropathy

4. Osteoporosis
5. Segmental Instability

The aging spine

The spine after maturity starts to show signs of wear and tear. The first sign is disc degenerative changes visible on MRI. Once there is 50% disc degeneration with facet arthritis, the disc collapses giving rise to ankylosis. The main concern here is that the compression of the disc space leads to unfavourable degenerative changes which lead to canal stenosis. Spondylosis and deformity. The clinical syndrome of scoliosis is this created by these changes.

Clinical presentation

The typical clinical presentation caused by secondary compression of the neural structures along with instability and deformity. **Back pain** with radicular radiation occasionally associated with paraesthesia. This is of gradual onset, and slow progression, worse in the mornings. The pain improves once the day's activity begins, worsening again by the end of the day. The curve and the symptoms are both caused by the spinal degeneration. Treatment therefore generally focuses on the degeneration. Generalised backache can be usually due to muscle fatigue. The more pathognomonic pain is focussed which can imply disc degeneration, facet arthropathy or rotatory subluxation with lateral listhesis. Not all pain requires corrective surgery. Symptomatic management in early stages and in mild cases is also effective. Pain markers in degenerative scoliosis include

- Lateral vertebral olisthy, (side slip)
- L3 and L4 endplate obliquity angles,
- Decrease in lumbar lordosis,
- Increased thoraco-lumbar kyphosis

These features are shown in figure 2 along with assessment using the coronal plumb line

The Cobb angle is used to detect the extent of deformity in scoliosis. However, the Cobb angle of the scoliotic deformity had no statistically significant correlation to the Visual Analogue Scale for pain. **Neurogenic claudication** is mainly caused due to rotatory

subluxation which causes central or foraminal stenosis. **Radiculopathy** is also commonly seen at the L3 or L4 roots by foraminal or extraforaminal stenosis at the concave side and at the L5 or S1 nerve roots due to lateral recess stenosis at the convex side

Important details of the disease can be obtained by asking family History to detect familial syndromes or other causes of scoliosis such as neuromuscular disorders, Date of Onset, Measured Curve Progression, The Presence or Absence of Pain as an intent for surgical correction, Bowel or Bladder Dysfunction which is an absolute indication for surgery, Motor Function, especially Lower Limb weakness and its duration to determine the need for surgery as well as the presence of previous spinal surgeries to ascertain the presence of weakened muscles. Physical examination is directed towards the local spinal examination and the neurological examination. Which completes the clinical battery. An oft understated aspect of scoliosis is the psychiatric aspect associated with poor image and social interaction. The primary motivator for surgery sometimes isn't neurological compression, or even pain but cosmesis which will allow greater social function. This is increasingly being considered as a vital aspect of scoliosis treatment

Curve Progression

Progression of scoliosis occurs as mentioned above where degeneration leads to disc and soft tissue integrity loss, functional unit instability coupled with facet arthropathy which leads to worsening of the deformity and compression. The neural compression and instability spur bony adaptation to correct the problem, leading to the secondary curves. The process is dynamic and progresses, as once the secondary curves form, they increase the stress on the disc and ligaments of the spine leading to further degeneration and instability. This is known as Wolff's Law.

Studies indicate that thoracolumbar curves between 50-75 degrees (Cobb's angle) have a propensity to increase by 22.3 degrees overall. The maximum progression occurs in the lumbar curves especially when the L5 vertebra isn't well seated leading to apical rotation greater than 33%

Investigations:

Imaging modalities are of high priority in scoliosis. These include X-ray to measure the degree of spinal curvature and overall alignment of the spine, Magnetic resonance (MR) imaging: Discs of the spine, the spinal cord, and spinal nerves., Computed tomography (CT) for detailed information about spine and pedicles and Myelograms for detailed information about the spinal cord.

poorer social function, as well as on **Coronal shift** > 4 cm which is also associated with Poorer function, Greater pain when compared to patients with a coronal shift < 4 cm.

Treatment:

Most cases of degenerative scoliosis respond to conservative management with medications, exercise, braces, with orthoses such as shoes. If osteoporosis is present then calcium and vitamin D supplements with or without hormone replacement therapy & exercises are prescribed.

Indication for surgery

Surgery is indicated in severe pain and disability not responding to conservative care. Here with other factors such as comorbidities, and osteoporosis are considered and when a favourable risk benefit ratio is obtained making the risk of surgery acceptable to the patient and the relatives alike. The goals of surgery are to decrease pain, improve neurological symptoms, prevent curve progression and stabilize the spine.

Surgical Options:

Standard surgical options involve neural element decompression with stabilisation and deformity correction. Lumbar Laminectomy is decompression of stenosed cord or nerve root due to bony spur or degenerated disc It is commonly done alone or along with stabilisation procedures. Spinal Fusion (combined with decompression) with or without cage is done for deformity correction stabilisation. This surgery also prevents progression. vertebral osteotomies which are only used in Lordosis causing sagittal imbalance. As far as the surgical approach is concerned, the Anterior fusion, which is preferred in normal lordosis, no

subluxation, Circumferential fusion in minimally lost lordosis, with marked subluxation and Posterior only fusion in marked loss of lordosis with marked sagittal imbalance. Fusion to sacrum is done for a loss of lordosis with an increasing positive sagittal balance. The options are summarised in the table below.

The commonest surgery performed for degenerative listhesis is the Lumbosacral junctional fusion at L5 S1 due to the increased incidence of instability and neurological compression that occurs at this junction. The surgery is generally performed for spondylolisthesis, severe coronal or sagittal deformity, severe lumbosacral pain localised to this level, degenerative disc disease requiring surgery, or for a case of previous decompression which has now developed deformity, instability or both. The advantages of the procedure are many. The most important is that degeneration is avoided at L5 S1 ensuring stability while sagittal plane correction is also achieved. The procedure also arrests progression of the disease with minimal adjacent vertebral degeneration. However, the disadvantages include a loss of mobility at the lumbosacral junction, possibility of pseudarthrosis as well as arthrosis and arthritis of the Sacro-iliac joint which may require prolonged treatment including further surgery.

Conclusion:

Degenerative scoliosis is a slow, progressive, age related morbidity usually treated conservatively. In patients with persistent symptoms (especially osteoporotic women and pts with neurological deficits), surgery is essential to improve their Activities of daily Living and quality of life.

Figures:



Figure1 showing the bend in the spine suggestive of scoliosis

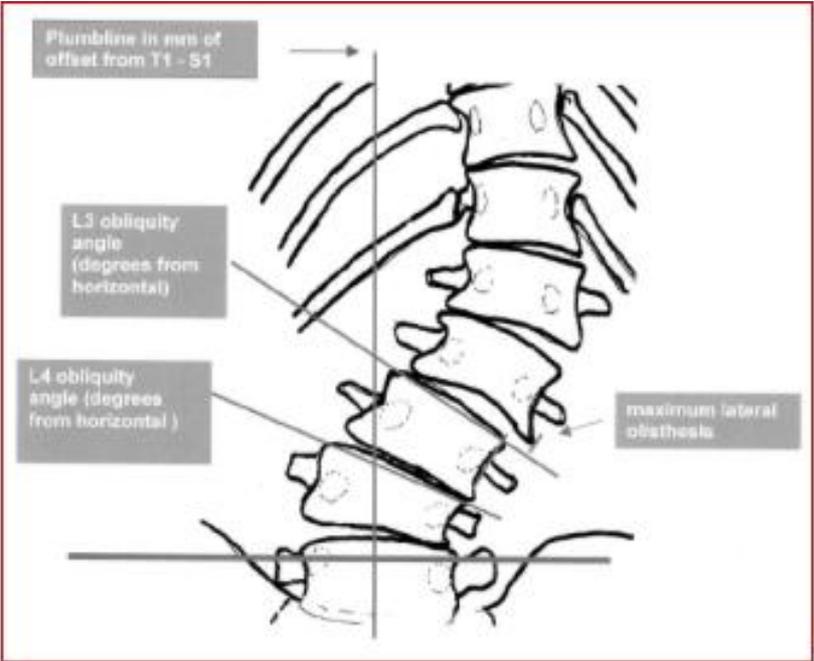


Figure2 showing the coronal depiction of the lumbar spine with scoliosis at D12-L1 with a side slip at L34 with endplate obliquity. This along with kyphosis increases the pain in degenerative scoliosis.

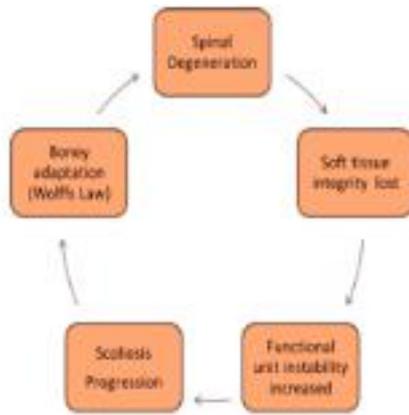


Figure 3 showing the Wolff Cycle and Wolff Law with respect to the progression of the degenerative process leading to scoliosis and neurogenic compression.



Figure 4 showing various imaging modalities in Degenerative scoliosis. (A) and (B) show an X-ray of the lumbar spine before and after fusion surgery depicting the listhesis with loss of lordosis which is corrected in (B). (C) shows an MRI sagittal view in T2 mode showing significant degenerative canal stenosis of the lumbar spine. (D) shows a CT of the lumbosacral spine where, significant osteoporosis and degeneration have led to canal stenosis and instability, and (E) where a myelogram shows a CSF leak due to sharp osteophytes puncturing the dura causing Intracranial Hypotension.

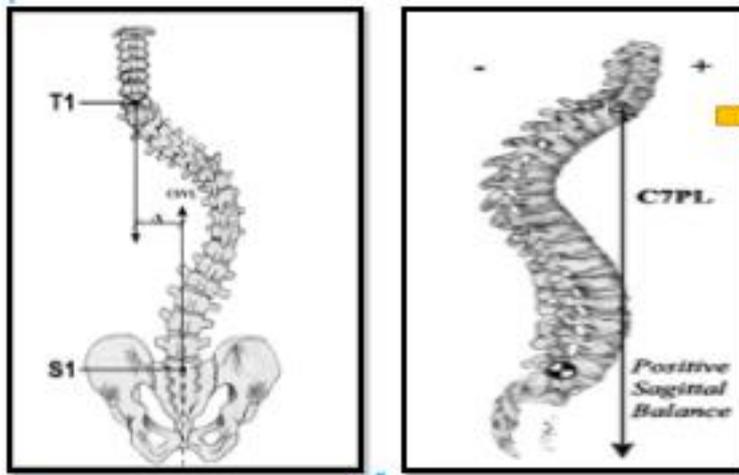


Figure 5 showing the coronal balance slip and sagittal balance moving anteriorly in degenerative scoliosis. The difference in plumb line placements shows the extent of the shift and deformity.

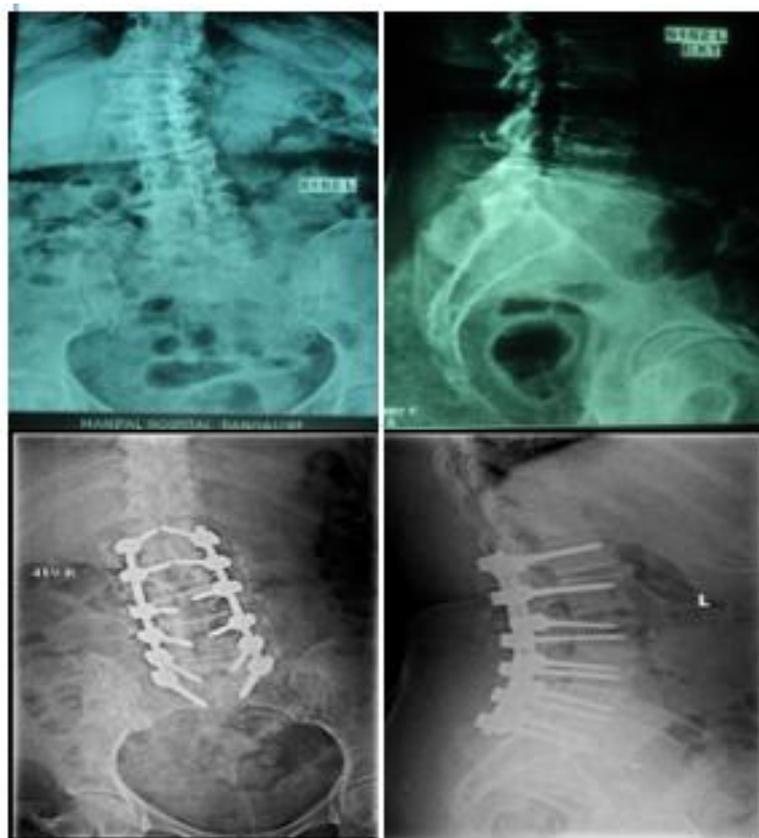


Figure 6 showing pre-operative and post spinal fusion images (using only a posterior approach) demonstrating the change in deformity along with stabilization and neural decompression.

Tables:

Table 1: Clinical features	
Back pain	Generalized Localized suggestive of focal spinal degeneration
Radiculopathy	
Neurological deficit	Sensory – paraesthesiae and anesthesia Motor weakness Bowel & bladder dysfunction
Neurogenic claudication indicating canal stenosis	
Visible deformity	

Table 2: Classification of Adult Deformity		
Type 1		thoracic-only curve (no other curves)
Type 2		upper thoracic major, apex T4-8
Type 3		lower thoracic major, apex T9-T10
Type 4		thoracolumbar major curve, apex T11-L1
Type 5		lumbar major curve, apex L2-L4
Type K		no scoliosis (<100), principal sagittal plane deformity
Lumbar Lordosis	A	marked lordosis >400
Modifier	B	moderate lordosis 0-400
	C	no lordosis present Cobb >00
Subluxation	0	no intervertebral subluxation any level
Modifier	+	maximal measured subluxation 1-6mm
	++	maximal subluxation ≥7mm
Sagittal Balance	N	normal, <4cm positive SVA
Modifier	P	positive, 4-9.5cm
	VP	very positive, >9.5cm

Table 3: Surgery for Degenerative Scoliosis

Procedure	indication
1.Fusion + decompression	Deformity correction + instability
1.1 Approach:	
1.1.1 Anterior	Normal lordosis + no subluxation
1.1.2 Circumferential	Minimal lordosis lost + maximum subluxation
1.1.3 Posterior	Marked lordosis lost + marked sagittal imbalance
1.2 Sacral fixation	Loss of lordosis + increased positive sagittal balance
2.Laminectomy alone	Only neural compression without instability or deformity
3.Vertebrae osteotomy	Focal lordosis causing sagittal imbalance

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