

Reviews

IDIOPATHIC SCOLIOSIS: KEY IDEAS OF SURGICAL TREATMENT.

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Abstract: Surgical treatment is generally indicated in patients with adolescent idiopathic scoliosis when the curve is greater than 50°. The most widely used technique is instrumented posterior arthrodesis with pedicle screws. Lenke's classification allows us to study the curve and correctly plan the intervention. Neurophysiological monitoring during the intervention has made it possible to increase the safety of the procedure. The most frequent complications after surgery are infection, problems related to the instrumentation, gastrointestinal and even ophthalmological.

Keywords: "scoliosis", "idiopathic adolescent scoliosis", "surgical treatment", "posterior vertebral arthrodesis", "complications".

1. OBJECTIVE AND INDICATIONS OF SURGICAL TREATMENT.

The objective of surgical treatment is to stop the evolution of the curve and correct the deformity with the least number of fused segments, obtaining a correct sagittal and coronal balance(1). In skeletally immature patients, in general, surgical treatment is indicated in curves greater than 50° (thoracic) or 45° (lumbar)(1)(2)(3).



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2. STUDY OF THE SURGICAL CURVE

In 1983 King et al.(4) established a classification system to select the fusion levels of patients with idiopathic scoliosis based on the posterior approach and Harrington bars.

This system was widely used, however, it was based solely on the coronal plane and focused mainly on the thoracic curves. Lenke et al.(5) recognized the need for a

more reliable and comprehensive classification, which takes into account the deformity in the three planes of space and which helps decision-making in surgical treatment with greater inter- and intra-observer agreement.

Thus, in 2001, they proposed a new classification system that is currently the most widely used(6). For this, we will need four X-rays: study of the complete spine in standing position in anteroposterior and lateral projection, as well as bendings to the left and right. Next, we must follow three steps to correctly classify the curve:

A) Identify the major curve, the minor curves and the structural curves.

The largest curve will be the curve of greatest magnitude and is always considered structural. we know crazy

Use the apex of the same to define the type of curve of the Lenke classification. The minor curves are the compensating curves adjacent to the major curve. They are defined as structural if in the lateral bending radiograph they maintain a Cobb angle greater than or equal to 25°, or kyphosis

T2-T5 in the case of proximal thoracic curves or T10-L2 in the rest, is greater than or equal to 20°.

Based on these criteria we can classify the curves into 6 types as shown in Table 1.

Table 1: Lenke's classification.

GUY	PROXIMAL THORACIC MAL (apex T3-T5)	THORACIC MAIN (apex T6-disc T11-T12)	THORACOLUMBAR /LUMBAR (apex T12 L1// disk L1-L2 L4)	CURVE TYPE
1	non-structural	Structural (elderly)	non-structural	main thoracic
2	Structural	Structural (elderly)	non-structural	double thoracic
3	non-structural	Structural (elderly)	Structural	double major
4	Structural	Structural (elderly)	Structural (elderly)	triple major
5	non-structural	non-structural	Structural (elderly)	Thoracolumbar/Lumbar
6	non-structural	Structural	Structural (elderly)	Thoracolumbar/Lumbar-Principal Thoracic

is criteria	Lateral bending \dot{y}	Lateral bending \dot{y}	Lateral bending \dot{y}	
structurality	25°	25°	25°	
of curves I	Kyphosis T2-T5 \dot{y}	T20-L2 kyphosis \dot{y}	Kyphosis T0-L2 \dot{y}	
nores	20°	20°	20°	

B) Lumbar modifier (A, B, C).

It is assigned based on the position through which the "Central Vertical Sacral Line" (CVSL) crosses the apical vertebra of the Thoracolumbar curve.

Modifier A: The CVSL crosses in the middle of the pedicles of the thoracolumbar apical vertebra.

Modifier B: SLVC crosses the medial border of the pedicle or the lateral margin of the thoracolumbar apical vertebra on the concave side.

Modifier C: SLVC crosses completely medial to the concave edge of the lateral margin of the Thoracolumbar apical vertebra.

C) Thoracic sagittal modifier (-, N, +).

It is defined based on the Cobb angle in the segment T5-T12.

Negative (-): If the thoracic kyphosis is less than 10°

Normal (N): If the thoracic kyphosis is between 10 and 40° included.

Positive (+): if the thoracic kyphosis is greater than 40°.

3. SELECTION OF FUSION LEVELS

We must take into account a series of basic principles of fusion(7):

- The main curve and the minor structures must be merged.
- It is necessary to avoid ending the instrumentation at the apex of both a sagittal and coronal curve.
- The end of the fusion must be balanced with the sacrum.
- The level of proximal fusion, in general, should include the most proximal vertebra of the curve is structural. In the case of scoliosis that includes the thoracic spine, we must pay attention to the shoulders.

- o If left shoulder elevated extend fusion to T2-T3

- o If shoulders are clinically balanced extend fusion to T3-T4

- o If the elevated right shoulder extends the fusion to T4-T5 or proximal final vertebra of the curve.

- o Remember the immediate postoperative imbalance of the shoulders is balanced in the

41% with fusions extending to Q4 (8)

- The distal fusion level, in general, should include the most distal vertebra of the structural curve.

Table 2 summarizes the criteria for selecting the level based on the type of curve of Lenke.

Table 2: Recommended melting levels according to the type of Lenke curve.

Lenke curve	selective merger	instrumented vertebra proximal end	vertebra instrument end distal end
1 (Main Thoracic) Yes.	Lumbar fusion is optional in curves with modifier C and rotation means tive.	T2-T3: left shoulder high T3-T4: Balanced shoulders brados T4-T5: right shoulder high	vertebra touched by CVSL or neu vertebra tra.a
2 (Double Thoracic)	Yeah. Lumbar fusion is optional in curves with modifier C and rotation means tive.	T2	vertebra touched by CVSL or neu vertebra tra.a
3 (Double major)	No	T2-T3: left shoulder high T3-T4: Balanced shoulders brados T4-T5: right shoulder high	distal end vertebra of the curve.b
4 (Triple major)	No	proximal end vertebra of the curve	distal end vertebra of the curve.b
5 (Thoracolumbar/Lumbar)	Yeah. Lumbar fusion is optional in curves with modifier C and rotation means tive.	proximal end vertebra of the curve	distal end vertebra of the curve.b
6 (Thoracolumbar/lumbar-thoracic major)	No	T2-T3: left shoulder high T3-T4: Balanced shoulders brados T4-T5: right shoulder high	distal end vertebra of the curve.b

a If the neutral vertebra and the distal end vertebra of the curve are the same or there is one level of difference. If there are two or more levels of difference, the final instrumented level is recommended to be a level cephalic to the neutral vertebra.

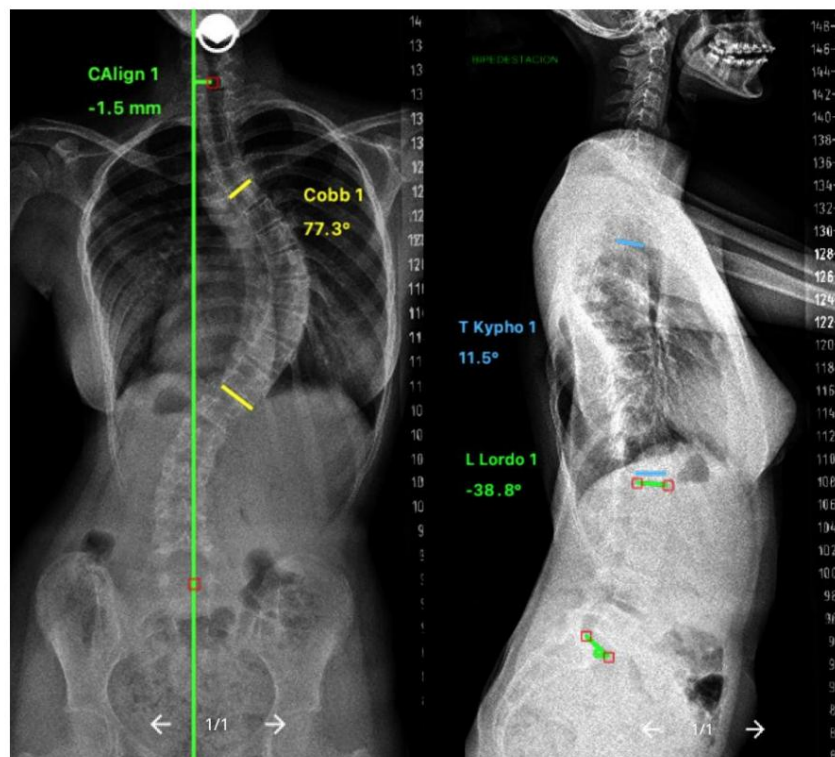
^b One level cephalad to the distal end vertebra of the structural curve if it crosses the midline and derotates on the bending radiograph to the convex side of the curve

Below is a case example of a female patient diagnosed with adolescent idiopathic scoliosis (Figure 1).

It presents a main thoracic curve (T5-T12) of 77°. The apical vertebra is T9. The vertebra touched by CVSL is L1. The neutral vertebra is L2. Shoulders seem balanced or well, the right one somewhat high.

Selective T5-L1 thoracic fusion was decided.

Figure 1: Example of a clinical case of a patient with adolescent idiopathic scoliosis treated by posterior arthrodesis (selective thoracic fusion).

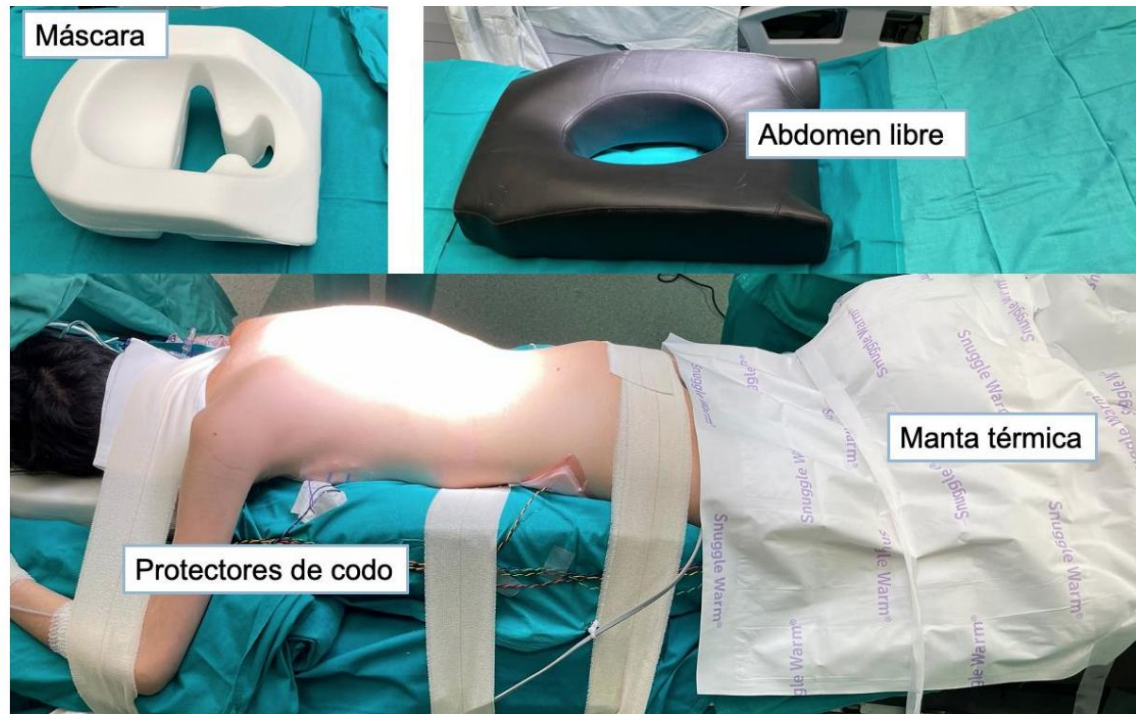




4. SURGICAL TREATMENT

Posterior vertebral arthrodesis is the most used (75% of cases), followed by anterior and combined(9). The patient is placed in the prone position on a frame or sled to maintain free abdomen and reduce intraoperative bleeding due to venous congestion. The head is controlled with a mask that allows proper support of the face without interfering with anesthesia, and the shoulders and elbows must be properly padded (figure 2). The intervention is performed with neurophysiological control of somatosensory and motor evoked potentials and electromyography.

Figure 2: Positioning of the patient on the operating room table.



The posterior approach to the spine is performed centered in the midline over the spinous processes. The length of the incision will depend on the levels to be fixed. The column is skeletonized and depending from the rigidity of the curve, the release phase begins to make it more flexible. Initially, the soft tissues, the interspinous ligament, and the ligamentum flavum at the apex of the deformity are resected. If a greater release is required to achieve a greater correction, osteotomy is performed. multilevel Schwab type 1 and 2 mine from the apex to the ends as needed (figure 3 and 4). Approximately 5mm must be resected from the lower facet of each level that you want to develop arthro. These bone fragments can be used as an autograft later.

Figure 3: Surgical field and posterior approach to the spine.

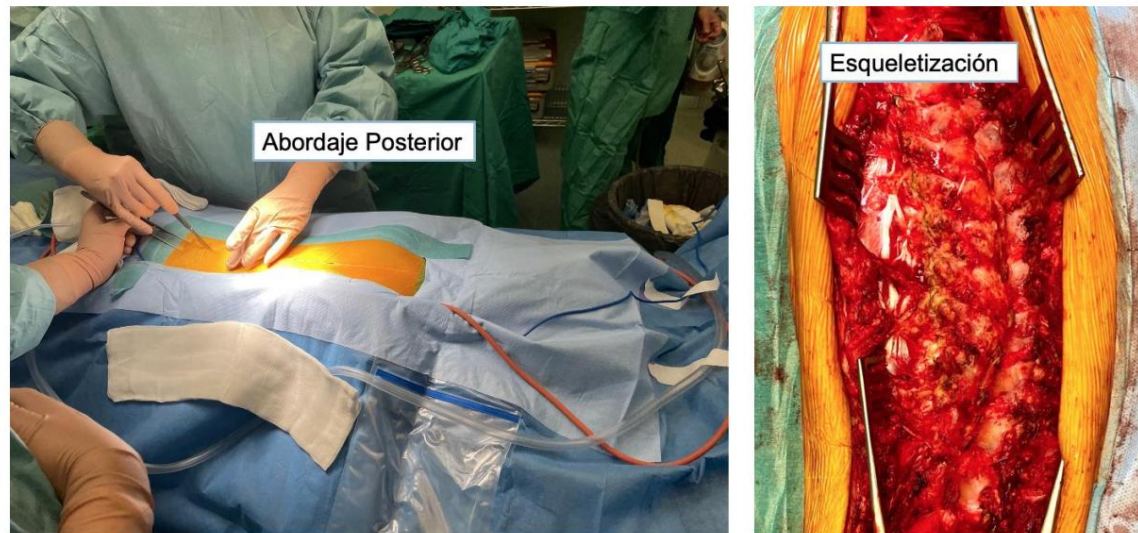
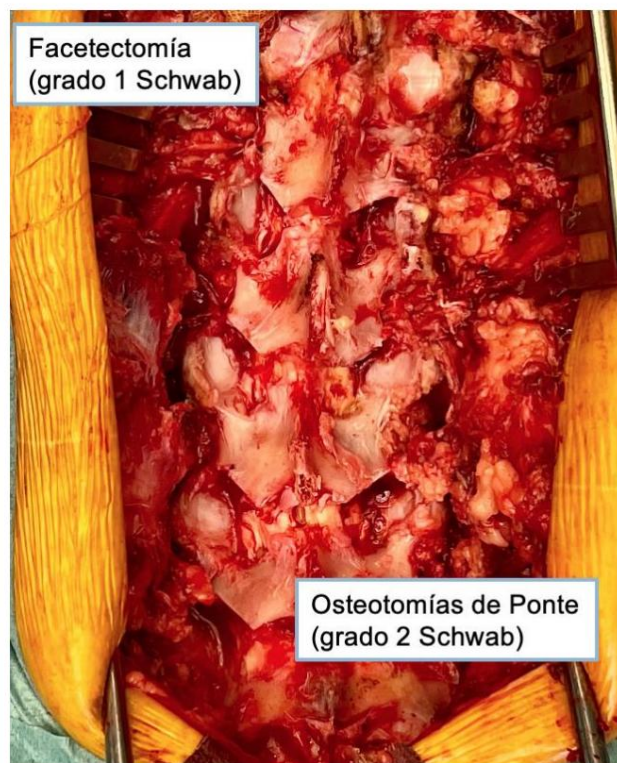


Figure 4: Intraoperative field image showing facetectomies and osteotomies of Ponte.



Next, the implementation phase begins. In general, the pedicle screws are implanted with the “free-hand” technique, controlled by intraoperative fluoroscopy and later by neurophysiology. The density of pedicle screws will depend on the surgeon and his surgical planning. Typically in the smaller magnitude and more flexible curves fewer implants will be used.

After that, deformity correction maneuvers are performed(10). These include: Compression and Distraction, In-Situ Contouring, Coronal and Sagittal Translation, Vertebral Derotation in Block, Direct Vertebral Rotation, Cantilever, Traction, Temporary Bars,... Finally, decortication of the laminae and transverse processes is performed and an autologous bone graft and bank allograft are provided.

5. COMPLICATIONS

Despite advances in new techniques, materials, technology and good surgical results, the rate of complications published by surgeons in general has remained more or less constant(11). We highlight the most important:

Infection (1.2%-1.3%). Depending on the time with respect to surgery we differentiate:

- Acute: Generally due to problems with the surgical wound. The freakest microorganism is *S. aureus*. Treatment consists of debridement and irrigation, maintaining the instrumentation to the extent possible. Consult a disease specialist infections and establish an adequate antibiotic regimen.
- Chronic: Deep infection. Generally by microorganisms such as *P. Acnes* and *S. Epidermi* *cos*. Treatment consists of debridement and irrigation, removal of implants, antibiotics and even negative pressure systems.

Pseudarthrosis (1-3%). It can manifest as pain, loosening and breakage of screws or bars. This complication has been reduced with the new pedicle screw implants.

Ophthalmological 0.01% - 1%

The alterations of the sympathetic chain (Bernar Horner Syndrome) and postoperative blindness whose etiology may be due to:

- Ischemic Optic Neuropathy (ION)
- Central Retinal Artery Occlusion
- Cortical blindness (heart attack)

Syndrome of Inappropriate Secretion of ADH.

Its characteristic symptoms are: headache, apathy, nausea and vomiting, consciousness disorders and in severe cases coma, seizures, apnea and death. It is diagnosed by $Na < 130$ mEq/L in serum and $Na > 50$ mEq/L in urine. Treatment is based on fluid restriction.

Superior Mesenteric Artery Syndrome (CAST SYNDROME).

Caused by a pseudo-obstruction of the 3rd portion of the duodenum. The treatment is based on absolute diet, nasogastric tube and parenteral nutrition.

Add-on. It is defined as the progression of the deformity in the non-instrumented segment.

Crankshaft phenomenon: it is defined as the progression of the deformity in the instrumental segment.
tado.

Neurological deficits (0.5-0.7%). Due to root injury or spinal cord injury during the instrumentation process or vascular cause, when carrying out the correction maneuvers. The treatment is based in medullary protection measures, controlling the patient's temperature, ventilation tension, need for transfusion and reversing the maneuvers that have produced it. It is necessary to detect it intraoperatively by neurophysiological monitoring.

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