Anterior, open short segment bone-on-bone correction for single curve idiopathic scolioisis

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INTRODUCTION

This approach for surgical reconstruction of flexible, moderate severity, single curve idiopathic scoliosis provides better correction over fewer segments, with faster healing, fewer complications and better functional outcomes than the alternatives, in the hands of the author.

Bone-on-bone vertebral apposition is essential in correcting the major curve. However, when the entire intervertebral disc is removed, major vertebrectomy must not be performed adjacent to the disc space. Major vertebrectomy will narrow the intervertebral foramen and compromise the segmental nerve root. This "total discectomy" approach is uniquely responsible for the success of the "short segment bone-on-bone" approach.

Any spinal implant system can be used to obtain and create and maintain interbody apposition, once the discs are removed and the vertebral bodies are apposed. The author favors dual rod implants, but other surgeons have used many different implant systems. And single implant systems have been successfully used - particularly by dr Daniel Zarzycki.

INDICATIONS

The technique is appropriate for single curve idiopathic scoliosis when the major curve is 85 degrees or less, and at least 50% flexible on "stretch." Compensatory curves must be 50 degrees or less and, also, more than 50% flexible on "stretch.

90% of patients i see in my office who require surgical correction of idiopathic scoliosis are candidates for this surgical approach.

The procedure is contraindicated in patients with severe restrictive pulmonary disease, severe scoliosis and in patients with absolutely identically matched double primary curves. It has not been used to treat neuromuscular or congenital scoliosis.

CREATING A PRE-OPERATIVE PLAN

For curves which fit the indications for the procedure, a surgical "plan" is created using a "stretch film." This plan will describe which vertebrae will be instrumented and which discs will be removed during the procedure. (fig. 1a and b) The surgical plan is occasionally, but rarely, modified in the operating room, after removal of the apical discs, to get the apical segments of the deformity as "straight" as possible, over the chosen levels. The limit of correction is when "bone-on-bone" apposition is achieved thru the instrumented segments.

Creating the pre-operative plan is essential for successful spinal reconstruction using the "short segment

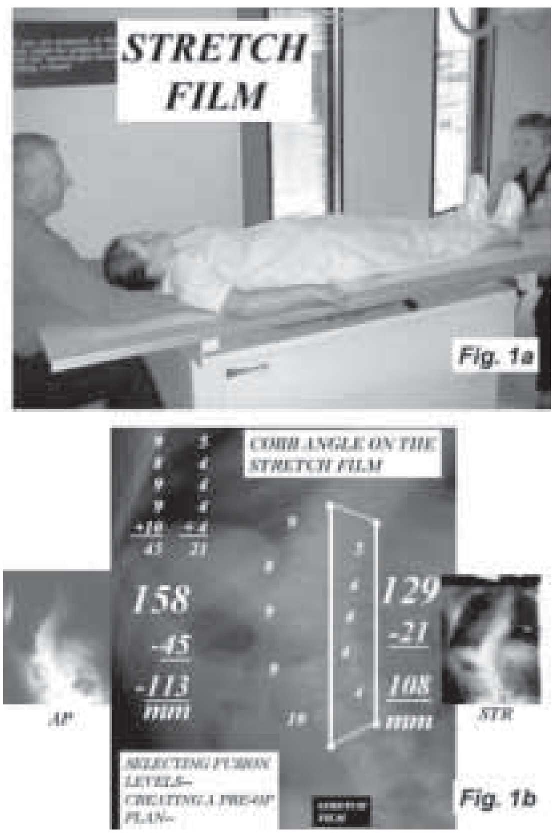


Fig. 1a. The "stretch film" is made by two paramedical personnel. The key is not how hard they pull, but that the patient relaxes. They must pull firmly, but not violently. The "stretch film" must be a painfree procedure. A hyperextension film can also be made to assess the flexibility of the sagittal plane alignment, if desired. It is rarely done for idiopathic scoliosis.
Fig. 1b. The measurement technique to predict instrumentation levels and quality of surgical correction for short segment bone-on-bone scoliosis instrumentation.

bone-on-bone" technique. Measuring the thickness of the discs, and subtracting the sum of their thicknesses from the cord length on the concave and convex sides predicts, quite closely, the quality of correction which will occur when the discs are "totally" removed and the vertebrae brought together.

The correction of the major curve obtained by "total disectomy" and "bone-on-bone" apposition is always much, much greater than the curve flexibility shown by the "stretch film" 15-40 degrees greater.

OPERATIVE TECHNIQUE

The pre-operative plan is to remove the discs using "total discectomy" and to instrument the vertebrae included in the cobb angle on the stretch film.

The patient is positioned on a pegboard with the convex side of the curve up. The approach includes removing the rib which is attached to the vertebra one below the top level which will be instrumented (fig. 2a and b).

After exposure, the segmental vessels are ligated, the rib heads in the instrumented segment are amputated to expose the intervertebral foramena. "total disectomy" is then performed over those discs contained within the Cobb angle on the stretch film (fig. 2b, 3a and b).

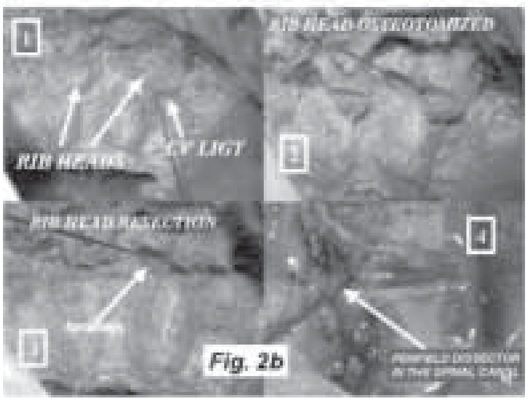
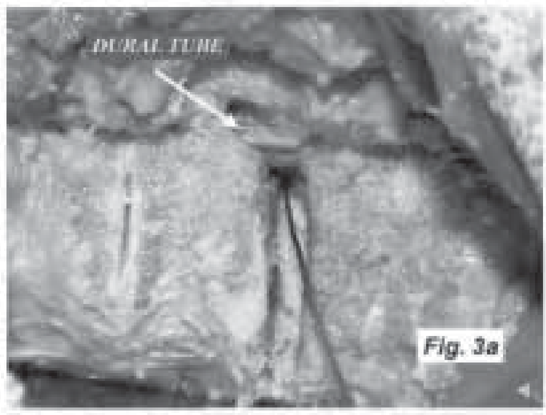


Fig. 2a. The patient is positioned on a pegboard with the convex side of the curve up. The skin incision follows the rib which attaches to the vertebra one below the upper intended vertebra which will be instrumented, i.e. if T8 will be the top level instrumented, the exposure will include removal of the 9th rib. 5 vertebrae and 4 discs can be easily accessed thru the bed of a single rib. Double thoracotomy is never necessary for this operation.
Fig. 2b. Once the rib is removed, the segmental vessels are doubly clamped and ligated over the instrumented segment. The heads of all the ribs attached to the vertebrae which lie in the instrumented segment are amputated back about 1 _ inches, so that the intervertebral foramen can be identified and probed. A Penfeld dissector is placed into the intervertebral foramen and dissected directly across the spinal canal to palpate the posterior aspect of the intervertebral discs in the instrumented segment. A little epidural bleeding is encountered during this dissection. It is easily controlled with one piece of thrombin soaked gelfoam at each level. This identifies the posterior limit of the "total discectomy." The posterior annulus of the intervertebral disc represents the sole structural barrier to achieving "bone-on-bone" apposition during short segment scoliosis correction. It must be removed. "Bone-on-bone" apposition is not possible without total removal of the posterior annulus at each level in the instrumented segment. This technique must be practiced in a cadaver lab prior to a surgical case. The technique is one which has been practiced for at least 30 years in safe removal of herniated thoracic inter-vertebral discs.



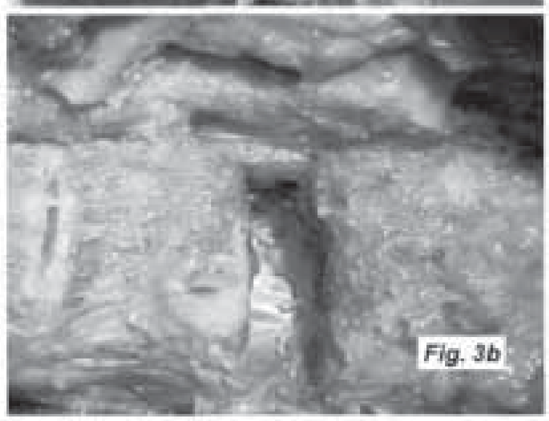


Fig. 3a. Here about 2/3rds of the disc has been removed, but the deep annulus and a substantial amount of posterior annulus still remains. This is the extent of discectomy which has usually been performed during "anterior release" procedures. It is not sufficient for "bone-on-bone" short segment instrumentation.
Fig. 3b. Here, the remainder of the disc tissue—including all the posterior annulus—has been removed—all the way to the other side of the spine. "Bone-on-bone" apposition can easily be achieved now, by simply compressing the two adjacent vertebrae together. Generally, once all the disc tissue has been removed, the two vertebrae just collapse together, and achieve "bone-on-bone" apposition with no effort from the operating surgeon.

When the apical segments are straightened maximally, and "bone-on-bone" apposition achieved, the flexible compensatory curves above and below the apical segments correct themselves. No surgery is necessary or appropriate to correct the compensatory curves.

In primary thoracic cases, generally 5 vertebrae and 4 discs are operated. In primary thoracolumbar cases, 3-4 vertebrae and 2-3 discs are reconstructed.

Once the discs are removed and the implants placed, the instrumented vertebrae are compressed to achieve "bone-on-bone" apposition. At least a part of the adjacent vertebrae much touch. If there are small gaps remaining once "bone-on-bone" apposition is achieved, these gaps can be filled with morselized autogenous bone from any source. The quality of correction is assessed clinically and with the image intensifier. All the correction is achieved with the first rod - both coronal and sagittal balance. The second rod is used routinely, but only for stabilization - not correction (figs. 4-7).

In operating primary thoracic cases, bone-on-bone apposition routinely restores normal sagittal plane balance in the instrumented segment. When doing primary thoracolumbar curves, interbody cages are occasionally necessary to produce normal sagittal plane alignment. Their need must be individualized, since many patients don't need them. They are very rarely necessary above the l2-3 interspace, but more regularly necessary at l3-4 and l4-5 (fig. 8-12).

Pain control is achieved by the use of an epidural catheter with infusion of fentanyl by infusion pump. This is left in place until the 4th day when it is gradually weaned and replaced with oral analgesics. The epidural catheter is generally removed on the 5th postoperative day.

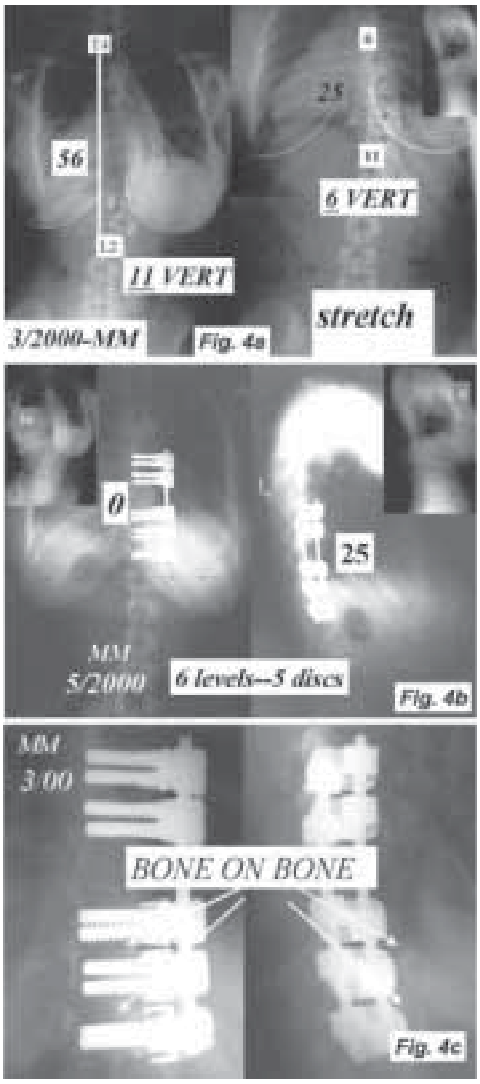


Fig. 4a. A typical adolescent with a 56 degree curve. The common instrumentation levels would be T6 to L2 - 11 vertebrae/10 discs. the stretch film shows the Cobb angle down to 25 degrees over 6 vertebrae—half the levels typically operated by "posterior segmental instrumentation with pedicle screws".
Fig. 4b. The post-op correction is to straight, over 6 vertebrae/5 discs. In addition, 25 degrees of kyphosis are created at the apex of the "hypokyphotic segment" over the instrumented levels by "bone-on-bone" apposition.
Fig. 4c. There is "bone-on-bone" apposition at each level in the instrumented segment.

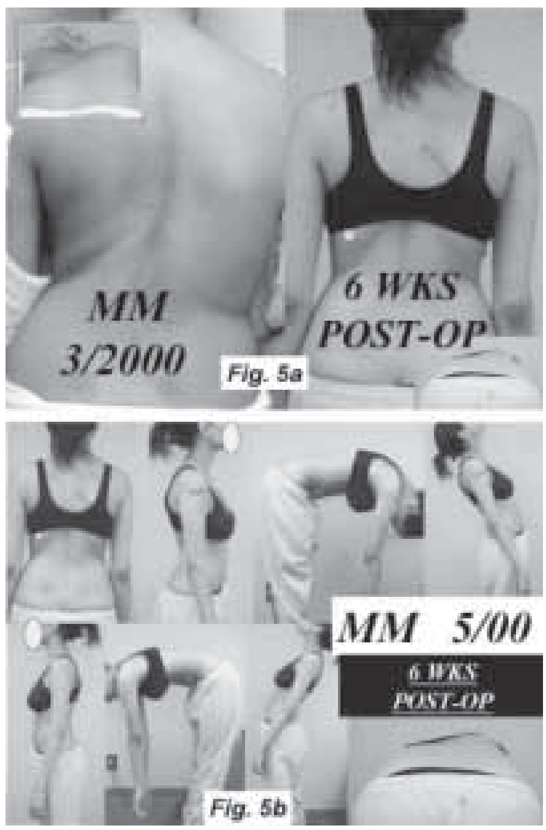


Fig. 5a. The pre and post op photos show the quality of the correction. The rib hump photos are in the insets. They show the quality of rib hump correction.
Fig. 5b. The patient's functional painless range of motion is illustrated in the photos made 6 weeks following the surgery. Her recovery is typical of the entire series —not accelerated or unusual.

CLINICAL SERIES

120 cases have been performed over the last 10 years, so the follow-up includes many cases with 10 year follow-up, and 57 cases with over 5 year follow-up.

The mean age of the series is 19 years. 99 of the patients are female, 21 are male. All have had idiopathic scoliosis. The technique has been used twice for idiopathic appearing thoracic scoliosis in young children who also had symptomatic, and previously treated syringomyelia.

RESULTS

This technique has been used for 10 years. It has not been materially modified since it's introduction in 1996.

The quality of coronal plane correction is 76% for primary thoracic cases, and 84% for thoracolumbar cases. All of the cases have had their sagittal plane corrected into the normal range, both within the instrumented segment and for the entire spine.

Rib hump correction is demonstrated in the attached patient photographs. The rib head removal necessary to expose the foramen for "total discectomy" provides a substantial adjunct to the correction of the rib hump provided by correction of the spinal deformity. Several illustrative cases are shown (fig. 4-12).

There have been no implant-related problems of any kind. There have been no spinal cord related complications of any kind.

There are no patients who have had any kind of special management for nerve.

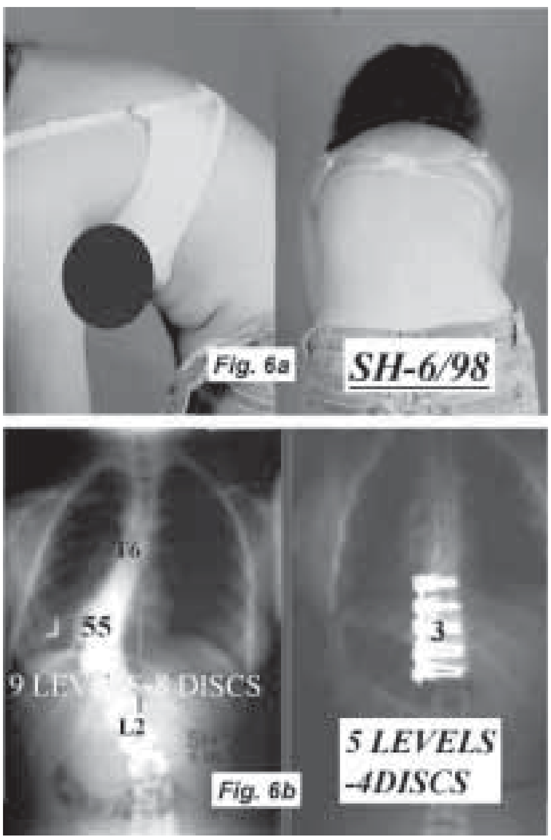


Fig. 6a. A high school student with a moderate left thoracic curve of 55 degrees had a normal MRI and no neurological findings.

Fig. 6b. Her pre and postop x-rays are illustrated. Posterior segmental instrumentation would have included 9 vertebrae and 8 discs. The bone-on-bone levels were 5 levels/4 discs, and the curve is basically straight. Bone-on-bone apposition allowed prompt healing at each level.

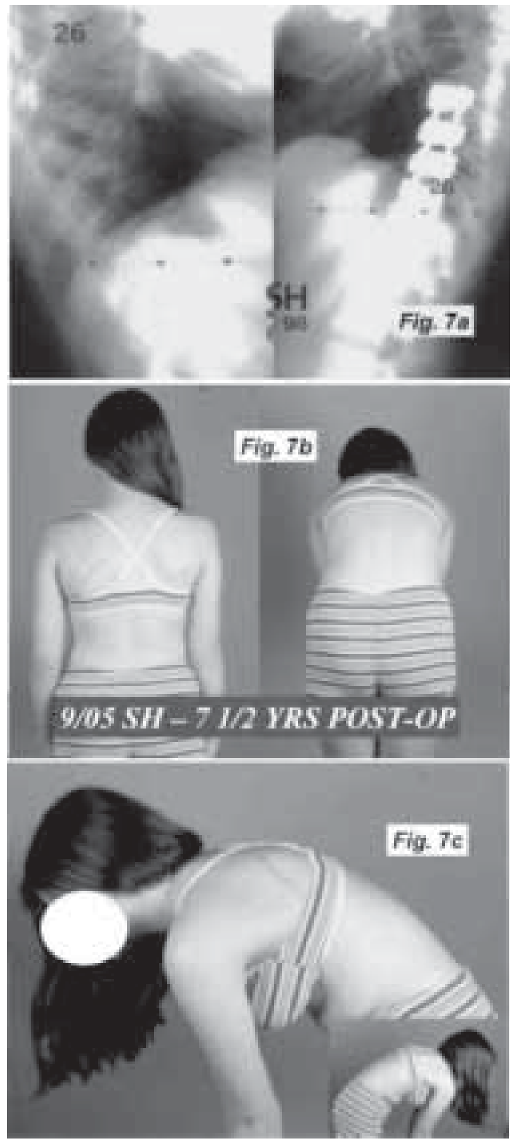


Fig. 7a. Her sagittal plane correction is shown pre and postoperatively. There is no change.

Fig. 7b. Her postoperative photos show the quality of coronal plane and rib hump correction and the quality of her sagittal plane balance. Her findings are typical of almost 50 primary thoracic patients in the entire series.

Fig. 7c. Her rib hump, coronal and sagittal plane alignment are demonstrated. The photos were made 7 years postoperatively.

Root injury in the surgical area, though most patients have numbness around.

Their incision for several months after their reconstruction.

There have been no life-threatening complications or deaths.

There have been no deep or superficial infections.

There have been no non-unions.

There has been no loss of correction in any of the patients and no progression

Of any compensatory curves, up to the present.

The long-term functional outcomes benefit substantially from the short segment instrumentation. Many very athletic patients show championship level participation. For those who are less athletic, work alternatives are expanded due to the short fusions and maintenance of spinal flexibility. Most patients perform in daily activities as if they are unlimited by their “spinal performance.” No patient complains about “spinal stiffness” during the accumulation of the entire series.

These results have been duplicated by dr Daniel Zarzycki, from Zakopane, Poland, in a series at least three times as large as the author’s series (over 350 cases). The follow-up in that series of cases is over 2 years. The correction, pace of healing, and complication rate are very similar to the author’s.

COMPLICATIONS

One patient had to have a post-operative thoracentesis within 4-7 days following chest tube removal.

There have been no cases of ARDS, pneumonia, pulmonary emboli, pneumothorax, or pyothorax. There are no cases of post-operative clinical pulmonary compromise or functional limitations of any kind.

No patients take narcotics for more than 4-8 weeks following their surgery.

Teenagers generally can return to school within 6-8 weeks after the reconstruction. Young adults and adults generally return to work a little slower than the teenagers.

One patient, who had his surgery in 1997, had to have his fusion extended. His compensatory curves were too large and stiff and were outside the recommendations included at the present. His posterior surgery added 3 levels. He was nicely rebalanced by his posterior reconstruction.

Virtually all the correction in this technique results from “total discectomy”.

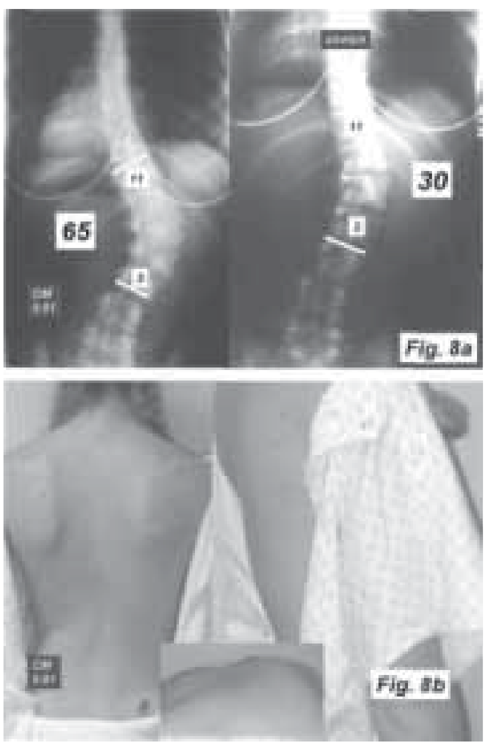


Fig. 8a. A primary thoracolumbar curve is illustrated in a 22 year old woman. Her primary curve is 65 degrees and her stretch film is 30 degrees. Her correction will be obtained over 4 vertebrae/ 3 discs.

Fig. 8b. Her preoperative photos illustrate the deformity.

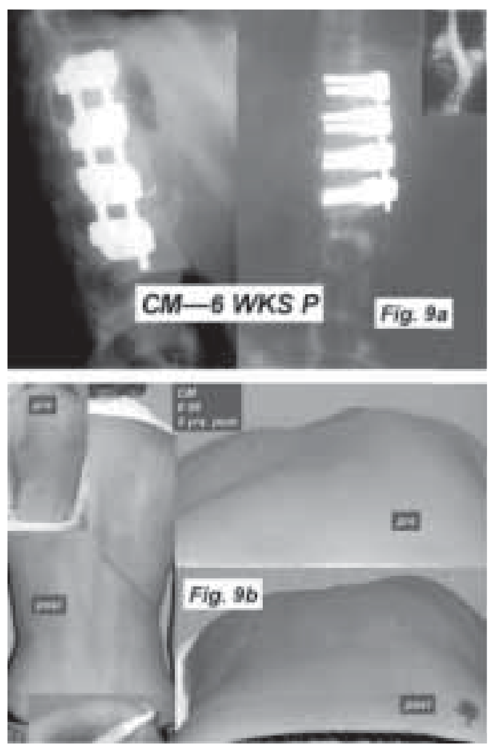


Fig. 9a. Her postop x-rays demonstrate the quality of correction and well maintained sagittal plane alignment without interbody grafts. Full correction of the coronal and sagittal planes are achieved over 4 vertebrae/3 discs.

Fig. 9b. The post operative photos show the quality of correction of her coronal, sagittal planes and the quality of correction of her rotational malalignment, as well. Pre-operative photos are in the insets.

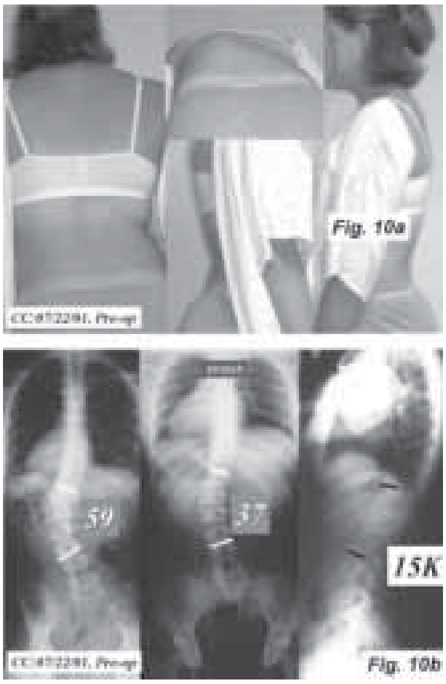


Fig. 10a. A teenager with a primary thoracolumbar curve. The photos document the decompensation and the rotational deformity, as well as the coronal plane deformity.
Fig. 10b. Her primary curve is 59 degrees, which corrects to 37 degrees on the stretch film. Her lateral film shows 15 degrees of kyphosis over the apical segments. This kyphosis must be corrected to physiologic alignment during the reconstruction.

Therefore, the cord length from end vertebra to end vertebrae is measured in mm. on the concave and convex sides of the major curve. The total thickness of the discs (measured from the stretch x-ray) between these end vertebrae is then subtracted from the cord length on that side. The convex disc thickness total is subtracted from the convex cord length. Identical calculations are done on the concave side of the curve. In a normal straight spine, the two measurements are the same. In a scoliotic spine, when the two final cord lengths (after subtracting the thickness of the discs) are within 5-10 mm, the procedure will get the apical part of the curve straight. If there is more than a 10mm difference in the final measurements, consideration should be given to perhaps including one more deformed disc in the instrumented segment., or removing small bony wedges to reshape particularly wedged vertebrae - without compromising the foramen.

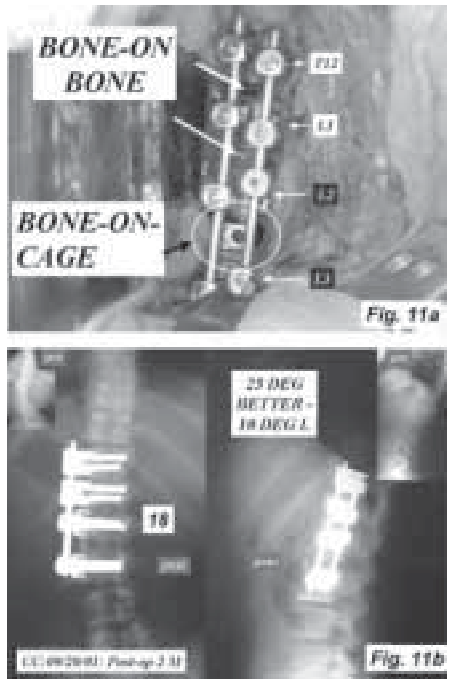


Fig. 11a. An intraoperative photo shows that the proximal two interspaces were approximated and corrected by "bone-on-bone" apposition. The L2-3 interspace was reconstructed with a carbon spacer to restore normal lordosis at this segment.
Fig. 11b. Postoperative x-rays show that the primary curve has been corrected to 18 degrees and the cage has restored normal lordosis thru the instrumented segment. Overall sagittal plane alignment has been improved by 25 degrees.

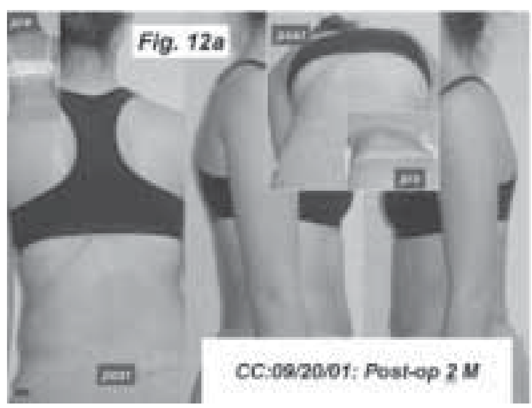


Fig. 12a. Postoperative photos show the quality of post operative correction of the coronal, and sagittal planes, and the rotational malalignment. Preoperative photos are in the insets. She is 5 years postoperative now. There has been no loss of correction.

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