Adult Scoliosis: Evaluation And Treatment

Sunday U. Ero, M.D. and Peter Blessey, M.D.

Scoliosis is defined as a frontal plain curvature of the spine greater than 10° with structural rotation at the apical segment. The incidence of adult scoliosis is estimated to be between 4% to 8%.[1] Scoliosis in adults can be the consequence of a process that began before skeletal maturity (adolescent idiopathic scoliosis) or the scoliosis can arise, "de novo", in adult life secondary to osteoporosis, osteomalacia or latrogenic causes such as multilevel decompression for spinal stenosis and degenerative changes. This article will focus primarily on the resulting spinal deformity that began to develop before skeletal maturity. However, the principles apply to other forms of adult scoliosis. Treatment philosophies (goals) in adult scoliosis differ markedly from scoliosis in the skeletally immature group. When evaluating and treating scoliosis in the adolescent population, the emphasis is on preventing the complications that occur from scoliosis in adult life. Whereas, in adult scoliosis, since the scoliosis deformity has already occurred, treatment is directed at managing rather than preventing the complications of scoliosis.

Natural History

A review of the natural history of adult scoliosis reveals several facts about the pathogenesis of the disease process while helping us to identify certain groups at risk for complications. It has been shown in multiple studies that scoliotic curves in the adult may progress and the curves were often painful.[2] Weinstein and Poncetti[3] showed that the patients with thoracic curves of 50° to 75° were at the highest risk of progression with an average progression of 30° over a 40 year followup period. Thoracolumbar curves progress an average 18° during the same followup period. On the other hand, curves of less than 30° at maturity are unlikely to progress. The effects of pregnancy on scoliosis progression have been reviewed by multiple authors. Betz and Associates[4] reporting on 221 pregnancies found no correlation between the age of pregnancy, number of pregnancies, and curve stability at maturity, with curve progression.

Cardiopulmonary considerations are frequently the source of anxiety among physicians and patients. Spirometric pulmonary function tests are usually unaffected in the idiopathic scoliosis patients until the curve exceeds 60 to 65°,[5] and the mortality is unaffected until the curve exceeds 90 to 100°.[6] The likelihood of respiratory distress is greater in the neuromuscular group of patients than in patients with idiopathic curve. The subjective dyspnea experienced by patients with otherwise normal arterial blood gases can be explained by the diminishing compliance of the thoracic cage as the scoliosis increases, therefore, the work required in respiration increases.

Back pain related to adult scoliosis is somewhat controversial. Nachemson[7] has reported that adults with scoliosis have no greater rate of pain disability than non-scoliotics. Briard & Associates[8] noted that while the incidence of pain in adult scoliotics is no different than in non-scoliotics, it is frequently persistent and non-responsive to conservative treatment. Jackson & Associates[9] found that 83% had progressive or persistent pain and that pain increased with age and with the degree of deformity. The majority of the reports support the fact that pain is a common and serious problem among adult scoliotics. Pain may also present in the form of a symptom called spinal fatigue. Spinal fatigue is usually described as a vague aching pain in the area of the scoliosis segment. Usually it is only fully appreciated after the patient has undergone spinal reconstructive surgery, and the pain is noted to be gone and the patient feels an increase sense of well being at having lost this symptom of spinal fatigue.

While pain remains the primary symptom at presentation, some patients will identify curve progression and increasing deformity as their reason for seeking medical attention. Very rarely as has been explained above, patients may present with decreasing cardiopulmonary function usually in curves greater than 70°. While the potential neurologic deficits may be disabling, progressive adult scoliosis is not usually associated with paraparesis or paraplegia.

Patient Evaluation

A comprehensive history should be obtained including family history of scoliosis. A history of curve progression may not be well documented, but an attempt should be made to do so as the de novo scoliosis may progress at a faster rate than pre-existing curves. De novo curves may progress as rapidly as 3° per year.[10] While the usual progression rate for adolescent idiopathic curves of over 50° is about 1° per year. The location and quality of pain and its responsiveness to non-operative measures should be obtained. It is felt that pain localized to the apical segment will respond better to operative treatment. Relationship of pain to quality of life issues including – ADL, occupation,

***Sunday U. Ero, M.D.** is Assistant Professor / Chief, Orthopaedic Spine Service, Department of Orthopaedic Surgery for the University of Florida Health Science Center / Jacksonville.*

***Peter Blessey, M.D.** is an Orthopaedic Resident, Department of Orthopaedic Surgery for the University of Florida Health Science Center / Jacksonville.*

family and sexual life should be sought. Aggravating and relieving factors including possible radicular pain should be noted. History of bowel and bladder incontinence may be related to associated stenosis. While respiratory symptoms are rare, this should be a documented part of the history.

On physical examination, while focusing on the spinal deformity, a comprehensive physical examination is necessary including a full neurologic examination. The deformity examination should include palpation of the entire spine, ribs and pelvis in a patient who is completely disrobed except for the underwear. Adam's forward bending test is used to measure the thoracic or lumbar prominence as an estimation of the rotational deformity, though the degree of rotation can be measured on a hand held scoliometer. A plumb line dropped from C7 is of value in measuring the coronal plain decompensation from the gluteal cleft. Other significant factors in the examination include checking for associated clinical kyphosis or lordosis. Spinal flexibility and any recent decrease in height should be documented, as should any sign of subtle neurologic changes that might suggest syringomyelia.

Radiographic Assessment

Radiographic assessment begins with standing PA and lateral views on 14 X 36" cassette. The Cobb method is most commonly used to determine the degree of curvature in the PA view. This is done by first locating the superior and inferior end vertebra. An end vertebra is vertebra with the maximum tilt into the concavity of the curve being measured. Next draw the intersecting perpendiculars from the superior surface of the superior end vertebra and from the inferior surface of the inferior end vertebra. The angle formed by the intersecting lines is the angle of the curve. Lordosis and kyphosis are assessed on the lateral films. Oblique stagnara views may be required to obtain a true PA view because of the rotational deformity. This is done by obtaining an oblique radiograph with the cassette parallel to the medial aspect of the rotational rib prominence. A film made at 90° to this will give a true lateral view. It is important to determine the flexibility and thus correctability of the curve for pre-operative planning by supine side bending films.

A computer tomography scan (CT) and myelography may be beneficial for those patients with radicular pain or stenotic symptoms. Magnetic resonance imaging (MRI) will also be beneficial in this group of patients and will show degenerative disc disease and thus may be helpful in planning fusion levels. However, the CT/myelography is superior in diagnosing lateral recess stenosis compared with MRI. While discography has been recommended by some authors to aid in deciding the distal level of fusion, there has been no universal agreement on the reproducibility and reliability of discograms.[1] Therefore, we do not routinely use discograms in the workup of the adult scoliosis patient.

Treatment

The treatment of adult patients with scoliosis requires a synthesis of principles derived from adolescent management and consideration of the biochemical and mechanical consequences of the aging process. The physician must maintain a balanced approach between non-operative and surgical treatment, while addressing the main clinical problems of back pain, curve progression and decompensation. Other possible pathologic processes including bony and soft tissue tumors, congenital scoliosis, syringomyelia, tethered cord, and infection must be ruled out before formulating any treatment plan.[14]

The non-operative treatment plan is formulated much along the lines of that for chronic low back pain with the main essentials including medication, physical therapy and orthotics. However, the patient must understand certain considerations that the chronic nature of the deformity and pain, and accept that activity modification may be required. Whereas, this lifestyle altering modification is difficult for many patients to accept, it is important that they be active participants in the pain control process.

Medications

Non-steroidal anti-inflammatory drugs are frequently helpful in patients with painful scoliosis. While there are several non-steroidal anti-inflammatory agents on the market, other considerations including renal, hematologic and gastrointestinal side effects need to be considered before making a choice. The Cox-2 prostaglandin inhibitors are expected to have much less gastrointestinal side effects compared to its predecessors. Narcotic pain medications do not have a place in the chronic management of painful scoliosis. However, they can be used on selected occasions for periods not more than 72 hours during active exacerbation of the pain.

Physical Therapy / Exercises

A low impact aerobic exercise program including walking, swimming, cycling and selected weight training exercises can help improve cardiopulmonary reserve, promote endorphin production, control weight, and possibly delay or retard onset of age related osteoporosis. While this program can be initiated in a hospital setting by a professional physical therapist, it is important for patients to make these activities a part of their regular routine on a life-long basis.

Orthotics

Orthotic use in adults is for pain control. There is no evidence that prolonged brace wear in adult scoliosis changes the natural history of progression. Braces are mostly used for pain control in those patients where surgery is not

indicated or where medical contraindications preclude surgical treatment. It should be used on an as needed basis; patients should be encouraged to engage in activities without a brace in order to avoid undesirable deconditioning of the trunk and abdominal musculature.

Surgical Treatment

The management of the symptomatic adult patients with idiopathic scoliosis is complex. The indications for surgical treatment include:

- Thoracic curve (> 50°) in a patient with chronic recurring, disabling pain related to the curve and unrelieved by conservative treatment.
- The thoracic curvature greater than 60° in a patient with increasing respiratory symptoms.
- Lumbar curve associated with back or radicular pain or symptoms of spinal stenosis.
- A large (> 50°) thoracic or lumbar curve with documented progression.
- Thoracolumbar curve with rotatory subluxation and producing increased decompensation.

Operative treatment of adult scoliosis is generally considered more difficult than that of adolescent scoliosis because of the high complication rate and less predictable result. The differences are mostly due to the less predictable factors of osteopenia, disc degeneration and facet arthritis in the adult population. Documented complicating factors include residual pain (30%), paralysis (< 2%), and instrument failure (10%). Pseudoarthrosis (5%-30%), infection (5%), pulmonary (10%), mortality (2%), and variable rate of sagittal decompensation depending on the distal extent of the fusion. With a reported overall complication rate as high as 80%, it is imperative that the treating physician not only be aware of the risks and benefits of adult scoliosis surgery but fully discuss them with the patients and family.[10]

Since the introduction of the Harrington rod in 1960 there have been many advancements in spinal instrumentation including the development of the newer segmental systems which utilize double rods, multiple hooks and/or screws fixation. By allowing multiple fixation sites, these segmental systems truly allow for segmental correction of the spinal deformity with near anatomic sagittal reconstruction. However, the goal of all surgical treatment has remained the same to produce a stable and balanced spine that is painless. To do so, proper selection of the fusion levels must be adhered to. The proximal and distal extent of the fusion must be in what is termed the neutral zone. If the thoracic curve is the source of the patient's complaint, a compensatory lumbar curve may be excluded from the fusion. However, if the compensatory lumbar curve is deemed degenerative, as per MRI or CT /myelo studies and painful as per discograms, then it should be included in the fusion. While this is controversial, a patient that would otherwise be fuse to L3 but has painful degenerative disc disease at L3-4, L4-5 and L5-S1 may benefit from incorporation of these levels into the fusion.[11]

There are three main techniques and approaches for correction of scoliotic deformity.

1. Posterior only segmental instrumentation and fusion. This is usually for flexible thoracic and thoracolumbar curves. This technique utilizes posterior segmental instrumentation and bone grafting in the selected fusion levels.
2. Anterior only instrumentation and fusion. This is usually for flexible thoracolumbar or lumbar curves. The advantage of the anterior instrumentation and fusion is usually due to the fact that fewer spinal segments are instrumented while producing a greater percentage correction.
3. Anterior and posterior fusion techniques are usually reserved for large and very rigid curves. The anterior part of this procedure is designed to relieve the stiff spine through multiple diskectomies and sometimes osteotomy, and provide interbody fusion. The posterior procedure is similar to the posterior only approach and technique. This posterior procedure may be done under the same anesthesia as the anterior procedure or staged for a later date. The time differential in the staged procedures may vary from days and up to two weeks. However, with the advent of highly specialized intraoperative support services including anesthesia, autologous transfusion and cell saver use, neurologic monitoring, same day anterior/posterior procedures are being safely performed with increasing occurrence.

Other surgical considerations include thoracoplasty, which is the removal of multiple 5 cm rib segments from adjacent ribs (4 to 6) in the area of the rib prominence. While this is mostly of cosmetic value, it also provides a much-needed source of bone graft for the fusion. Other sources of bone graft are iliac crest and spinal decortication. Allograft is increasingly being used as alternative and/or additional source of bone graft.

Illustrative Case

T.J. is a 23-year-old female who presented with a history of back pain progressively getting worse over the past year. She was diagnosed with scoliosis as a teenager and has had intermittent back pain, which seems to have gotten worse with two pregnancies and the delivery of her two children – ages 2 years and 10 months respectively at the time of

presentation. The patient also has a history of numbness involving the left leg mostly on prolonged standing.

Upon physical examination, she is about 5' 3" tall and weighs about 129 lbs. She has an obvious pelvic tilt with an elevated right hemipelvis. She also has an obvious deformity in the lumbar spine with left flank prominence. She walks with a gait pattern consistent with limb length inequality related to the pelvic tilt. Upon forward bending, the left flank prominence consistent with convexity of the lumbar curve is also the site of maximum pain. Clinical spinal rotation on forward bending measured about 17° with the scoliometer. Full-length scoliosis radiographs, AP view (Figure1) is remarkable for a thoracolumbar curve measuring 47° degrees T11 to L4 with apex to the left at L1-L2. The thoracic curve measures 25° T6 to T11.

With the diagnosis of adult idiopathic scoliosis, the patient was started on non-operative treatment that included a prescription of non-steroidal anti-inflammatory drugs, instruction on spinal strengthening exercises. Right and left bending x-rays were ordered to determine flexibility of the lumbar curve. Also, a MRI was ordered to evaluate for possible lumbar disc disease as a cause of back and leg pain. The MRI revealed multiple level lumbar disc degeneration, but no evidence of disc herniation. The left side bending radiographs revealed a decrease in lumbar curve size from 47° to 27° suggestive of moderate flexibility of the curve. At the two-month follow-up appointment, the patient continued to be significantly symptomatic. Due to the size of the curve and the persistence of symptoms that have been progressive in the past year, a recommendation for surgery was made for stabilization and fusion with partial correction of the scoliotic deformity via the anterior only approach. This I believe, will allow for fusion of a shorter segment and with more percentage correction. The patient underwent surgery successfully through a left thoracotomy approach with anterior interbody fusion and instrumentation (Synthes USA Universal Spine System). A combination of autograft (rib) and allograft were used for fusion.

Post-operative x-rays were remarkable for curve correction of >50% (lumbar curve 47° pre-operative) decreased to 20° (post-operative) (Figure2). The thoracic curve 26° decreased to 14° post-operative. The pelvic tilt is shown to level off significantly. The post-operative lateral radiograph (Figure3) shows excellent sagittal alignment.

The patient was well balanced clinically and maintained in a thoracolumbar sacral orthosis for three months. At four months post-operative, the patient is ambulating well with only minimal residual back pain, but also quite cognizant and satisfied with her new found balance and improved posture.

Discussion

Scoliosis can continue to progress after skeletal maturity causing problems of back pain and increasing spinal deformity. This underscores the fact that approximately 25 percent of patients requiring surgical treatment for scoliosis are adults. Aggressive surgical treatment in the form of spinal arthrodesis and instrumentation as indicated in symptomatic patients can be successful. Regardless of the type of instrumentation utilized for spinal fixation, the goal of surgical treatment is correction of the three-dimensional deformity, restoration of balance, while fusing the minimal number of spinal levels necessary for prevention of curve progression and maintaining some residual spinal mo-

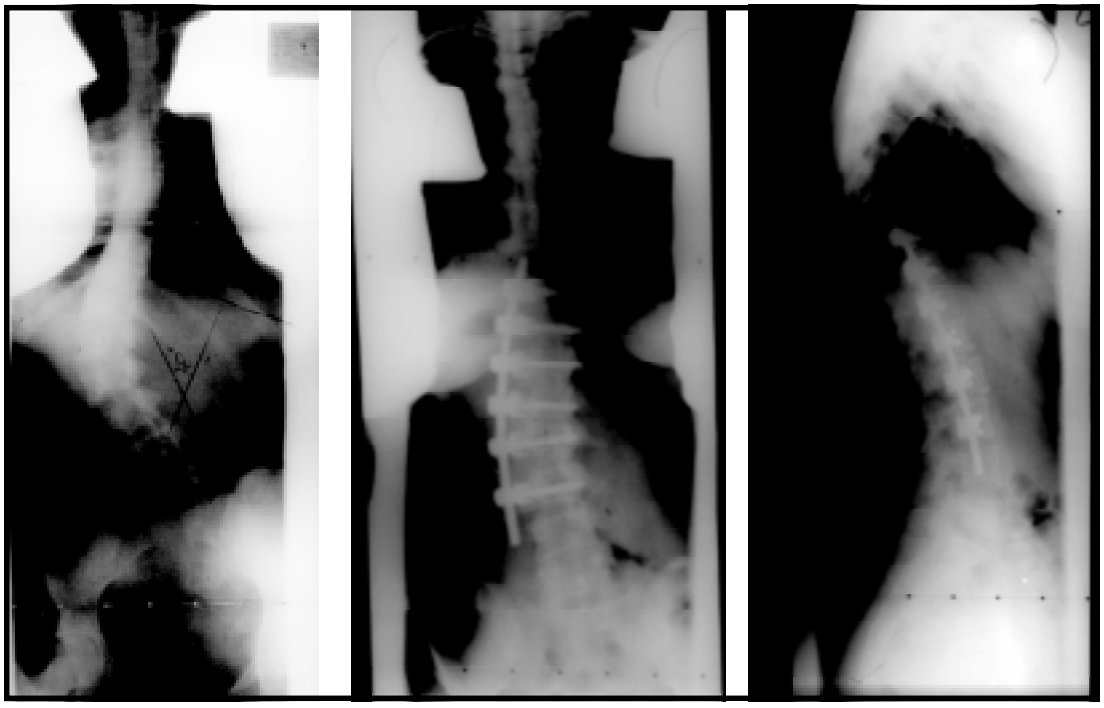

Figure 1 (Left). Pre-operative AP radiograph thoracolumbar spine. **Figure 2 (Center).** Post-operative AP radiograph thoracolumbar spine. **Figure 3 (Right).** Post-operative lateral radiograph thoracolumbar spine.

bility. Kostuik in 1984 obtained 70% satisfactory results in his group of adult scoliotic patients <50 years old treated with Harrington instrumentation. In a subsequent report in a similar patient population using Cotrell-Dubousset (CD) instrumentations, he obtained 85% satisfactory results. In 1994, the senior author[12] independently conducted a retrospective chart and radiographic review including patient completed questionnaire of a series of adult scoliotic patients using CD instrumentation by one surgeon (H.L. Shufflebarger, M.D.). In this series, the treatment period was between January 1988 through December of 1990 with the patient study population of 44. The treatment outcome in this series as perceived by the patients met or exceeded expectations in 94% of the population. Pain relief and satisfaction with cosmetic results were obtained in over 94% of the population. The activity level was improved or unchanged post-operatively in about 97% of the population. The average return to work time was about 12 weeks. All patients performed at the same or better level both in recreation or work. There was no pseudarthrosis or neurological deficits in this series. Whereas, cosmesis was the least important indication for surgery, it was found to be almost of equal importance to pain relief in the patient's perception of treatment outcome.

As shown in the case illustration, an adult who is younger than 35 years of age with or without pain, but with documented curve progression whose lumbar or thoracolumbar curve size measures about 45° or greater and imbalance is best treated surgically. This is because he/she will inevitably go on to develop a painful low back. This is also particularly true of a female patient with significant lumbar or thoracolumbar curve who, because of the degenerative changes may later convert from scoliosis with retention of lumbar lordosis to kypho-scoliosis which becomes rigid and may require a two staged surgery to correct.[13] In addition, the younger patients can be readily treated anteriorly with good correction of the deformity and minimal morbidity as shown in the case illustration.

As the population ages, the spinal surgeon will increasingly be presented with complex deformities with associated pain, loss of lordosis, imbalance, osteoporosis and spinal stenosis. With a better understanding of spinal mechanics, improved instrumentation, improved post-operative care and spinal fixation techniques, it is now quite possible to treat these patients with little resultant morbidity. While excellent functional and numerical outcome is possible in the treatment of the adult scoliotic, it is emphasized that failure of non-operative care remains the prime indication for surgical treatment.

REFERENCES

1. Bridwell KH. Adult Idiopathic and Degenerative Scoliosis. *OKU-Spine 1st Ed*. 1997; 161-172.
2. Balderston RA, Albert TJ. Treatment of Adult Scoliosis. *J. South Orthop Assoc*. 1996. 5 (3): 229-37.
3. Weinstein SL, Zavala DC, Ponsetti I. Idiopathic scoliosis; Long-term follow-up and prognosis in untreated patients. *J Bone Joint Surg.* 1983; 63A: 702-712.
4. Betz RR, Bunnell WP, Lambracht-Mulier E, et al. Scoliosis and pregnancy. *J Bone Joint Surg.* 1987; 69A: 90-96.
5. Kostuik JP, Bentivoglio J. The incidence of low-back pain in adult scoliosis. *Spine.* 1981:6:268-273.
6. Nachemson A. A long-term follow-up study of non-treated scoliosis. *J Bone Joint Surg.* 1969; 51A:302-304.
7. Nachemson A. Adult scoliosis and back pain. *Spine.* 1979; 4:513-517.
8. Briard JL, Jegou D, Cauchoix J. Adult lumbar scoliosis. *Spine.* 1979; 4:432-526.
9. Jackson RP, Simmons EH, Stripinis D. Incidence and severity of back pain in adult idiopathic scoliosis. *Spine.* 1983; 8:749-756.
10. Nuber, GW, Schafer, MF: Surgical Management of Adult Scoliosis. *Clinical Orthopaedics*. 1986; Jul (208): 228-236.
11. van Dam BE. Operative treatment of Adult Scoliosis with Posterior Fusion and Instrumentation. *Orthop Clin North Am.* 1988; 19 (2):353-9.
12. Ero SU, Shufflebarger HL, Clark C. Surgical Treatment of Adult Ideopathic Scoliosis with Cortrel-dubousse Instrumentation. *Orthopaedic Transactions (JBJS)*. 1995-96; 19 (3):586.
13. Kostuik J. Adult Scoliosis. In Textbook of Spinal Surgery (Bridwell and Dewald) p. 249-276.
14. Ogilvie J. Adult Scoliosis: Evaluation and Treatment. AAOS – Instructional Course Lecture. 1992, pg 251-255.