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Degenerative lumbar scoliosis: features and surgical treatment

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Abstract Degenerative lumbar scoliosis is a de novo deformity of the spine occurring after the fourth or fifth decade of life in patients with no history of scoliosis in the growing age. We evaluated complications and functional and radiographic outcomes of twelve patients with degenerative lumbar scoliosis, treated by spinal decompression associated with posterolateral and/or interbody fusion. Mean lumbar scoliosis angle was 18° (SD=4°) and mean age at surgery was 57 years (SD=6 years). Average follow-up was 3.5 years. Surgical treatment consisted in decompression of one or more roots, associated with stabilization with pedicle screws and posterolateral fusion. To correct the deformity, the collapse of the disc was corrected by implanting a cage in the anterior interbody space. Clinical symptoms and functional tolerance for daily activities improved after surgery. Radiographic evaluation showed a reduction in the deformity on the frontal and sagittal planes. There were no infections, evidence of pseudoarthrosis, instrument-related failures or re-operations in this series. In patients with persisting pain caused by degenerative scoliosis associated with spinal stenosis, in whom conservative treatment has failed, spinal decompression and segmented fusion with instrumentation represents a valid treatment option.

Key words Scoliosis • Lumbar spine • Fusion • Disk degeneration

Introduction

Lumbar scoliosis is a three-dimensional deformity of the spine associated with structural alterations of the vertebral bodies. Lumbar scoliosis in adult life can be the result of its presentation during the growing age, or can be a *de novo* degenerative deformity [1–3]. In persons in whom lumbar scoliosis appeared in the growing age, the spine during adult life presents angular and rotational deformities of several vertebral segments. Moreover, the apex of the curve is in the vertebral body, and the spine has always one or more compensatory curves and worsens due to secondary osteoarthritis occurring on the vertebra-vertebra joints [4–6]. On the other hand, degenerative adult lumbar scoliosis usually occurs after the fourth or fifth decade of life in patients with no history of scoliosis; the curve is composed of a few vertebral bodies, and has its apex in the intervertebral space, most frequently at the L2-L3 or the L3-L4 level [3, 7, 8].

The initial causing factor of degenerative scoliosis is collapse of the intervertebral complex, producing lateral and rotational deformities [5, 7, 9, 10]. Other pathological changes include degeneration of the disk and of the ligamen-

tum flavum, and asymmetric hypertrophy of the facet joints [11, 12]. Consequently, there are translational and rotational shifts of the spine complex, causing loss of lumbar lordosis, lateral vertebral slipping, or lateral rotatory subluxation; sometimes spondylolisthesis is observed. Previous surgery, such as discectomy of a herniated disk, may cause asymmetric disk degeneration or may worsen preexisting degenerative changes. Some authors have reported that osteoporosis or osteomalacia increases the incidence of adult degenerative scoliosis, in that the weakening bones are responsible for the developing of instability patterns [8, 11, 13, 14].

Progression of degenerative lumbar scoliosis has been described to be of almost 3° per year [9]. Predicting factors of curve progression include a Cobb angle of 30° or more, lateral vertebral translation of 6 mm or more, apical rotation of the third grade [15], and the intercrest line passing through the body of the L5 vertebra [4, 9]. All the pathoanatomical changes decrease the spinal canal volume and lead to spinal stenosis, which may affect the spinal canal or the foramina and be directly responsible for the clinical symptoms [1, 3, 9, 16].

Patients with degenerative lumbar scoliosis frequently present low back pain with or without neurological symptoms such as radiculopathy and claudication [1, 3, 11, 17]. Pain is caused by disk and facet joint degeneration and it is more intense in patients with more pronounced loss of lumbar lordosis. The radiculopathy can be unilateral or bilateral and it is caused by irritation or compression of a nerve root on the concave side of the curve or by traction on the convex side (1,18). The symptoms are similar to those of spinal stenosis but there is no relief with forward bending or in the sitting position.

Conservative treatment of degenerative lumbar scoliosis may be beneficial, but when symptoms become persistent surgery should be considered [3, 5, 11]. Surgical options include decompression alone, or decompression and combined fusion with or without instrumentation [5]. In this paper, we evaluated complications and functional and radiographic outcomes of twelve patients affected by degenerative scoliosis and treated by decompression with posterolateral and/or interbody fusion.

Patients and methods

Twelve patients (5 men and 7 women) were surgically treated for degenerative lumbar scoliosis. Diagnosis of degenerative scoliosis, made at a mean age of 54 years (SD=3 years), was based on physical and radiographical examinations. Patients were excluded if they had history of scoliosis in the growing age or a previous spinal fracture. Mean age at surgery was 57 years (SD=6 years).

All patients complained of continuous low back pain, not responding to medical treatment, for at least 6 months. Pain intensity was quantified on a visual analogical scale. Radicular pain (unilateral or bilateral) was present in nine patients, while four patients reported claudication with limited walking distances.

Roentgenograms of the lumbar spine were taken in the anteroposterior and lateral views. Standing roentgenograms were performed because part of the deformity is neutralized on supine position. Mean lumbar scoliosis angle measured by the Cobb method was 18° (SD=4°). Common radiographic features were flattening of the normal lumbar lordosis (in 2 cases kyphosis was present), vertebral rotation, lateral olisthesis, disk space narrowing, and end-plate sclerosis. The apex of the curve was in the L2-L3 level in two patients, the L3-L4 level in seven patients, and the L4-L5 level in three patients. Osteoarthritic changes of the facet joints with stenosis of the spinal canal and foramina were seen at computed tomography (CT) or magnetic resonance imaging (MRI) in all patients (Fig. 1). The stenosis was more severe at the apex of the curve in the concavity.

Preoperative planning consisted in: choice of laminectomy and foraminotomy levels and side, and choice of extension of arthrodesis. Hemilaminectomy was performed within the entire segment of the degenerative lumbar scoliosis in nine patients, while three patients received complete laminectomy. The foraminotomy level and side were chosen considering the radiculopathy experienced by the patients, as the degenerative signs were usually more diffused on CT images. Foraminotomy was performed in six patients in one or two adjacent levels on the same side, in two patients in one level monolaterally, in three patients in one level bilaterally, and in one patient in three levels bilaterally. Depending on the apex of the deformity and the involved segments, the fusion level was L2-L4 in five cases, L2-L5 in four cases, L3-L5 in two cases and L1-S1 in one case.

All patients were operated under general anesthesia in prone position. Attention was paid on positioning the patient on the operating table, placing the pads properly in order to reduce intra-abdominal pressure. A longitudinal median skin incision was made over the lumbar spine. The incision was deepened to the spinal processes, which were progressively exposed by using a Cobb elevator. Subperiosteal exposure was continued to the laminas laterally until the transverse processes. At each level, after individuating the entry point for pedicle screw placement, the pedicle was cannulated with a K-wire and a C-arm image was taken to control correct position. Then, a screw was inserted after tapping. After insertion of all required screws and the two rods, laminectomy and/or foraminotomy were performed, according to the preoperative planning. After decorticating the exposed spine, homologus cancellous bone graft was added. In cases of severe disc collapse, posterior lumbar interbody fusion (PLIF) was performed on the side of the concavity of the curve. After removing the greater part of the facet joint unilaterally, the degenerated disk space was enlarged by using a spreader rounger and the whole disk material was removed. Part of the cartilage of the end plates was removed to expose cancellous bone. The disk height was restored by implanting a polyetheretherketone (PEEK) cage, filled with homologous cancellous bone graft. Compression was applied and part of the lumbar lordosis was regained. In these cases, posterolateral fusion was performed as described previously. Closure was routine.

Patients did not need intensive care unit monitoring. Rehabilitation, initiated the first day after surgery, consisted of passive and active movements of the legs and sitting position.

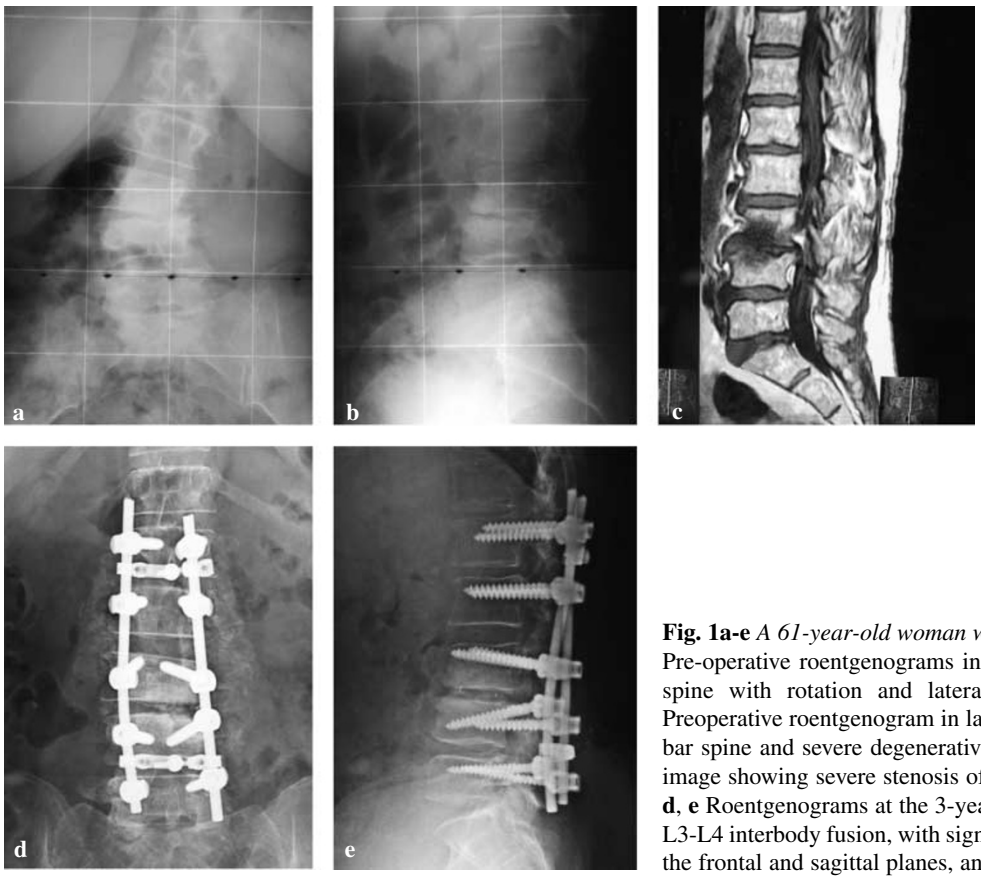

Fig. 1a-e *A 61-year-old woman with degenerative lumbar scoliosis.* **a** Pre-operative roentgenograms in anteroposterior view of the lumbar spine with rotation and lateral listhesis at the L3-L4 level. **b** Preoperative roentgenogram in lateral view with kyphosis of the lumbar spine and severe degenerative changes at the L3-L4 level. **c** MR image showing severe stenosis of the spinal canal at the L3-L4 level. **d**, **e** Roentgenograms at the 3-year follow-up show posterolateral and L3-L4 interbody fusion, with significant reduction of the deformity on the frontal and sagittal planes, and restoration of the disk height

Assisted ambulation started generally on the third postoperative day, depending on the patients' pain tolerance and general conditions. The patients were instructed to wear a semirigid brace while standing or walking during the first two postoperative months. When they could stand independently, roentgenograms were taken in the two views. Patients were discharged on an average of 10 days (SD=3 days). All patients were controlled clinically and radiographically monthly until the fourth month after surgery, then yearly. Average follow-up was 3.5 years (range, 2–5).

Results

One patient had a sac tear during the laminectomy, which was sutured and requested 10 days of bed rest in the postoperative period. No other intra-operative complications were observed in this series.

At the last follow-up, low back pain had improved in all patients compared to the pre-operative condition (Fig. 2). Neurological symptoms also improved. Four patients with severe claudication before surgery experienced remarkable improvement in walking distance. Radiculopathy, which was present in nine cases before surgery, was completely relieved in five, improved in three and improved but not completely resolved in one patient.

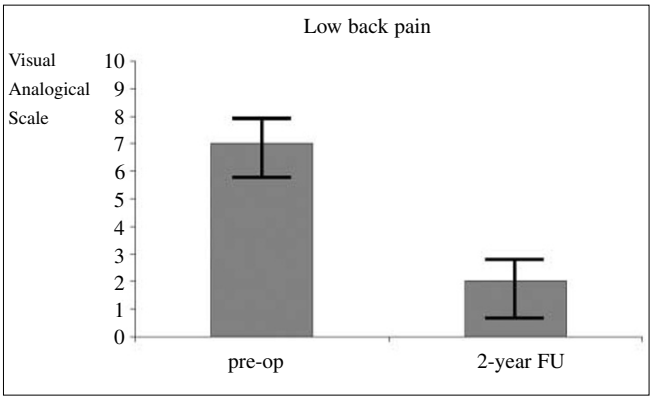

Fig. 2. Low back pain, preoperatively and at the 2-year follow-up, measured on a visual analog scale (0, no pain; 10, maximum imaginable pain)

All patients claimed that surgery had improved the functional tolerance for daily activities and had permitted them to return to activities that they had dropped because of pain. All of them said that they would repeat the surgery because it significantly improved the quality of their social lives.

Postoperative roentgenograms showed that surgery significantly reduced the deformity on the frontal plane; in

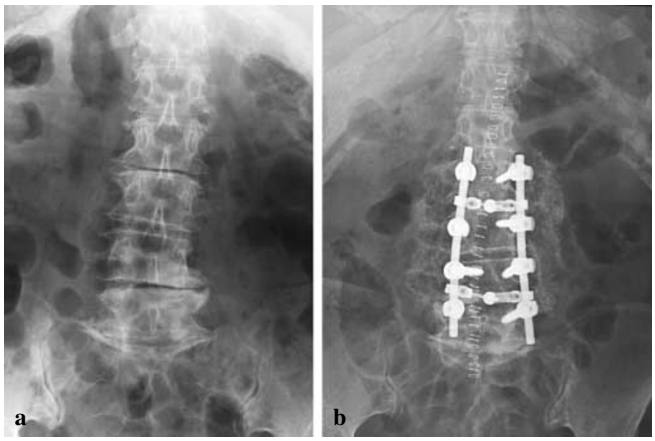

Fig. 3a, b *A 64-year-old woman with degenerative lumbar scoliosis*. **a** Preoperative radiograph shows the curve apex at the L4-L5 level. **b** Postoperative anteroposterior roentgenogram after hemilaminectomy of L3 and L4 and L2-L5 posterolateral fusion using pedicle screws

fact, the average postoperative curve was 8° (SD=4°) with an overall correction of 64%. The lumbar lordosis was partially or completely restored in all patients. When posterior lumbar interbody fusion (PLIF) technique had been performed, interbody fusion could be evaluated on plain roentgenograms because the cages used were radiolucent (Figs. 1, 3).

There were no infections, evidence of pseudoarthrosis, instrument-related failures or re-operations in this series.

Discussion

Degenerative scoliosis represents a frequent entity in the elderly population and very often it is associated with spinal stenosis [19]. This deformity is progressive and may limit patients in their activities of daily life. Initially, treatment should be conservative, consisting of steroidal or non-steroidal anti-inflammatory medications, physical therapy, soft or rigid spinal supports, epidural steroid infiltrations, and facet injections [6, 20]. Indications for surgery include unsuccessful nonoperative treatment, progression of the deformity, and worsening of clinical symptoms [6]. The goals of surgery are improvement of pain, restoration of function and arrest of deformity progression [8]. The less invasive surgical option is decompression without spinal fusion [12, 21]. It consists of laminectomy when the sac is compressed and of foraminotomy when compression interests one or more nerve roots. However, decompression alone may render the spine more unstable and worsen back pain and neurological symptoms [11, 18].

In patients with degenerative scoliosis, decompressive laminectomy and/or foraminotomy should be performed because spinal stenosis is always present. Posterolateral arthrodesis with instrumentation is recommended in addition to decompression in order to prevent long-term curve collapse. Pedicular fixation allows immediate stabilization of the spine, restoration of the lumbar lordosis, correction of the scoliotic deformity (combining compression on the convex side and distraction on the concave side of the curve), and firm fixation in the presence of osteoporotic bone [17, 19]. Spinal fusion should be applied to the decompressed levels and should not end at the apex of the curve [8, 11]. In presence of particular spinal instability, fusion of the anterior column should be considered using anterior, posterior or transforaminal interbody fusion with interbody cages. The use of cages facilitates load sharing, increases biomechanical stability, restores the intervertebral height of the intervertebral foramen and improves the stenosis [1, 22].

Simmons and Simmons [19] reported a series of patients with degenerative scoliosis and spinal stenosis treated by decompression combined with fusion and pedicle screw stabilization. Satisfactory outcome was reported in 93% of cases and no instrument-related failures or pseudoarthroses were noted. Marchesi and Aebi [20] emphasized that segmental pedicle instrumentation is beneficial in adult lumbar scoliosis in correction of the curve and restoration of the lumbar lordosis.

We believe that in patients with degenerative lumbar scoliosis, the indication for surgery depends on the symptomatology correlated with CT findings of stenosis and not solely on the entity of scoliosis. In fact, in our series the mean curve was 18°. Surgery aims to regain adequate space for the cauda and nerve roots without worsening the instability. For this reason, we performed posterior instrumented arthrodesis in all cases and, when necessary, the interbody discal space was restored using the PLIF technique. In patients with persisting pain caused by degenerative scoliosis associated with spinal stenosis, in whom conservative treatment has failed, we believe that decompression and segmented fusion with instrumentation represents the most adequate treatment option.

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