Complications and Outcomes of Lumbar Spine Surgery in Elderly People: A Review of the Literature

*Jordan M. Cloyd, BA, Frank L. Acosta, Jr, MD, and Christopher P. Ames, MD**

As the number of elderly persons in the United States continues to increase, there will be an associated increase in age-related diseases, such as degenerative conditions of the lumbar spine. Elderly patients frequently present to their geriatrician or primary care provider with low back and leg pain. Spine surgery is one of several options the geriatric patient may consider for symptomatic relief, but the literature describing the safety and efficacy of spine surgery in older patients is inconclusive and at times confusing. The purpose of this article is to describe common degenerative conditions of the lumbar spine and to review the complications and outcomes of spine surgery in elderly patients, with particular attention to how they compare with those of younger patients. A better understanding of the risks and prognosis associated with these types of surgeries will enable more-informed decision-making by patients and physicians. **J Am Geriatr Soc 56:1318–1327, 2008.**

Key words: lumbar spine; surgery; elderly; low back pain; complication; outcome; fusion

The ability to perform certain activities of daily living (ADLs) is a fundamental component of independence and is predictive of a positive quality of life (QOL). Low back and radicular leg pain (e.g., sciatica) are common causes of functional impairment and an inability to perform essential ADLs in elderly people. Furthermore, chronic disabling pain can significantly impair psychosocial functioning and lead to sleep disorders, depressive symptoms, and increased use of healthcare resources, particularly in elderly persons.[1] Recent evidence has linked frequent back pain in elderly women to coronary heart disease and overall mortality.[2] Thus, prompt recognition and treatment of back pain in the geriatric population is critical.

Currently, there are 36.1 million people (12.4% of the population) aged 65 and older living in the United States. This number is projected to increase to 71.5 million (19.6% of the population) by 2030.[3] As the number of elderly persons in the United States continues to increase, there will be an associated increase in age-related diseases, such as disorders of the spine. This will present a unique challenge to physicians, surgeons, patients, and their families as they weigh the additional risks of operative treatment against reducing disabling pain and improving QOL. Today, elderly people live longer and have more-active lifestyles. Factors such as the ability to tolerate surgery, rehabilitation, life expectancy, and overall health should be discussed when deciding treatment options for elderly patients with symptomatic spinal disease.

Surgery is one of several options to consider for the geriatric patient with lumbar spine disease. Although surgery in elderly patients has its clear benefits when appropriately indicated, it has been suggested that it is overused.[4] For example, the rates of lumbar fusion surgery over the past 2 decades have risen most rapidly in patients aged 60 and older.[5] Because these increases have not accompanied clarified indications or evidence of improved efficacy, some investigators have called for a better understanding of the correct surgical indications and associated risks inherent in treating the elderly population.[5] Unfortunately, the literature describing lumbar spine surgery in older patients is complicated and confusing. Therefore, the purpose of this article is to describe common degenerative disorders of the spine affecting elderly people and to conduct an extensive review of the literature regarding the risk of surgical complications and the clinical outcomes of elderly patients undergoing surgical procedures for degenerative lumbar spine disease.

THE AGING SPINE

Early biochemical changes in the intervetebral disc can lead to altered mechanics and damage accumulation. A loss of disc height occurs with aging and may place nonphysiological loads on adjacent segments as well as the facet joints, a common source of low back pain.[6] Changes in the

From the *Department of Neurological Surgery, University of California at San Francisco, San Francisco, California.

Address correspondence to Christopher P. Ames, Department of Neurological Surgery, University of California, San Francisco, 505 Parnassus Avenue, M779, Box 0112, San Francisco, CA 94143. E-mail: AmesC@neurosurg.ucsf.edu

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architecture and bone mineral density of the vertebrae lead to a stiffer yet weaker spine. Loss of lumbar lordosis and an increase in thoracic kyphosis give a "hunched over" appearance and are common changes that accompany aging. These factors, and others, can predispose to several degenerative conditions of the lumbar spine, discussed separately below, in older persons.

Spinal Stenosis

Spinal stenosis, a narrowing of the spinal canal, is a common cause of back and radicular pain in elderly people, occurring most often in the cervical and lumbar regions. Degeneration and bulging of the intervertebral disc anteriorly and hypertrophy of the facet joints and ligamentum flavum posteriorly cause it (Figure 1). These changes occur normally with aging. Compression of the dural sac and nerve roots may occur in the central canal, lateral recess, or neural foramina, although in elderly people, central and lateral stenosis frequently develop together. Spinal stenosis can be congenital or acquired. Factors that may lead to acquired stenosis include degenerative conditions of the spine (e.g., spondylosis, degenerative disc disease) trauma, spine surgery (post-laminectomy), and metabolic or endocrine abnormalities (e.g., osteoporosis, hypoparathyroidism).[7]

The classic presenting feature of lumbar spinal stenosis is neurogenic claudication, which refers to lower extremity pain that worsens with activity and is relieved by sitting or adopting a "hunched over" posture while walking. Patients may also report low back pain and numbness in the lower extremities, although severe cases can also result in motor disturbances and bladder or bowel dysfunction. In general, symptoms are bilateral, although one side is usually affected more than the other. The pathogenesis of these symptoms is not completely understood but most likely involves compression of nerve roots and disruption of neural blood supply.[8] Unlike disc disease, pain decreases with sitting and flexion of the spine, which is attributed to an increased diameter of the spinal canal and flattening of the ligamentum flavum, relieving compression on the neural elements and increasing microcirculation. Unfortunately, imaging studies do not correlate well with symptoms of stenosis in elderly people, indicating that canal narrowing is only one component of the etiology of symptomatic stenosis. Therefore, the term "spinal stenosis" should refer diagnostically to a clinical syndrome and not radiological or pathological findings.[8]

Degenerative Spondylolisthesis

Spondylolisthesis is any displacement of the rostral vertebral body, pedicles, and superior articular facets in relation to the caudal vertebral body and posterior elements (Figure 2). More frequent in women, spondylolisthesis may be degenerative (due to osteoarthritis of the facet joints and loss of ligamentous support), traumatic, postsurgical (due to adjacent segment disease), isthmic (due to spondylolysis), or congenital. Degenerative spondylolisthesis occurs most often at the L4 to L5 motion segment and is a disease of older adults, rarely affecting persons younger than 50.[9] It results in a compromise of the spinal canal and worsening of spinal stenosis but also can cause back pain and radiculopathy. Plain radiographs are generally sufficient to diagnose listhesis. Grading should be done according to the Meyerding scale, with Grade I, II, III, and IV referring to 25%, 50%, 75%, and 100% displacement, respectively.[10] If neural compression is suspected, then a magnetic resonance imaging (MRI) scan or myelogram with computed tomography (CT) should be ordered.

Degenerative Scoliosis

Adult degenerative scoliosis, differentiated from adolescent or idiopathic scoliosis, involves the development of a de novo rotational deformity in the adult years.[11] The pathogenesis is thought to be asymmetric degeneration of the intervertebral disc or facet joint that leads to a rotatory effect, with one side of the facet joint serving as the "pivot."[11] Osteoporosis can aid in the progression and development of degenerative scoliosis in elderly people, although the exact relationship between the two remains undetermined.[9] Primary degenerative scoliosis is mostly a lumbar or thoracolumbar disorder and is often accompanied by other degenerative changes of the spine, including spondylolisthesis and lumbar stenosis. It consists of coronal and sagittal (in the form of flatback or kyphosis) plane deviation (Figure 3).[11] Symptoms are similar to those of lumbar spinal stenosis, although patients also present with back pain and concerns about spinal deformity.

Vertebral Fractures

Osteoporosis is a metabolic disorder characterized by decreased bone mineral density. Type I occurs in women after

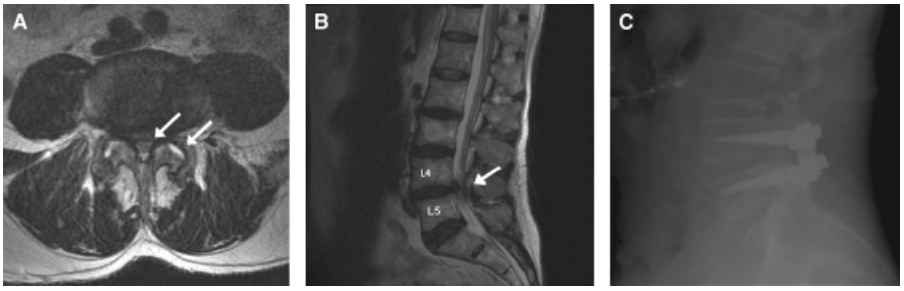

Figure 1. Seventy-six-year-old man with spinal stenosis at the L4 to L5 level. (A) Axial MR image at L4 to L5 level. Note compressed thecal sac and lumbar nerve roots with bulging intervertebral disc and hypertrophy of facet joints. (B) Preoperative sagittal magnetic resonance imaging indicating severe canal stenosis at L4 to L5 level. (C) Postoperative plain lateral radiograph. Because of severe degenerative disc disease and extensive posterior decompression, spinal fusion with pedicle screw and rod fixation was performed.

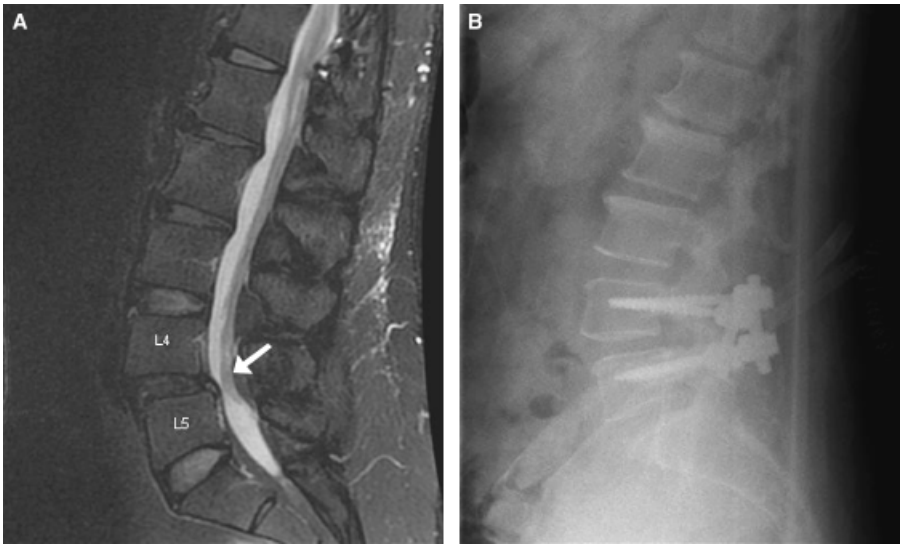

Figure 2. Sixty-eight-year-old woman with Grade I degenerative spondylolisthesis at the L4 to L5 level. (A) Preoperative sagittal magnetic resonance imaging scan indicating spondylolisthesis with moderate neural compression. (B) Postoperative lateral X-ray; patient was treated with single-level transforaminal lumbar interbody fusion with supplemental pedicle screw and rod fixation.

the onset of menopause as a result of decreased estrogen and increased bone resorption. Type II, also known as senile osteoporosis, occurs in men and women aged 70 and older as a result of age-related metabolic changes in regulation of calcium, vitamin D, and other nutrients. Persons with poor bone quality are at significant risk for osteoporotic vertebral compression fractures (OVCFs). In postmenopausal white women, there is a 15% to 25% lifetime risk of clinically diagnosed vertebral fractures, and the incidence of fractures in men due to osteoporosis is approaching that of women.[12] Back pain, height loss, and kyphotic deformity is the characteristic presentation, although many patients with diagnosed OVCFs remain asymptomatic. Physical examination may reveal tenderness over the fractured vertebra, although this does not distinguish between a fracture of the anterior and posterior elements. An increasing number of medical reports have indicated that OVCFs can lead to serious neurological deficits as well.[13] The most frequent site of fracture is the thoracolumbar junction, with the midthoracic site being the second most frequent location. In general, plain radiographs are sufficient to diagnose OVCFs, although MRI may help exclude vertebral compression due to tumor or infection.

NONOPERATIVE TREATMENT

In patients without emergent neurological deficits or acutely worsening symptoms, one or more trials of nonoperative therapy should be attempted. Nonsteroidal antiinflammatory drugs, acetaminophen, opioid analgesics, epidural medications, flexibility and strengthening exercise programs, and patient education are all helpful in the management of acute low back pain. Interventional procedures, such as corticosteroid injections and electrothermal therapy, may provide therapeutic benefit for select patients; evidence-based guidelines on these treatment options have

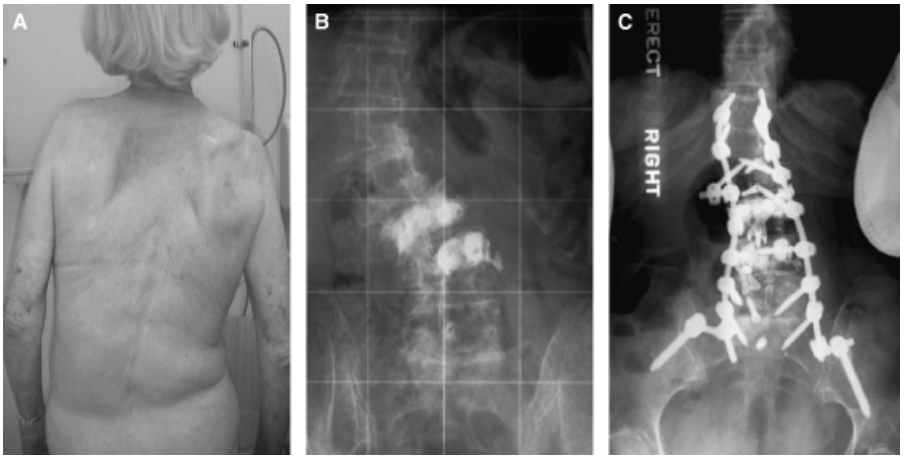

Figure 3. Seventy-five-year-old woman with degenerative scoliosis and lumbar compression fracture. (A) Standing preoperative assessment. (B) Preoperative anteroposterior plain radiograph demonstrating severe lumbar coronal curvature. (C) Postoperative anteroposterior X-ray after the patient was treated with a seven-level combined anterior-posterior fusion using anterior lumbar interbody fusion and posterior pedicle screw-rod fixation to the ilium. Note improved regional coronal curvature.

recently been published.[14] Alternatives that have not been proven to be effective but may be beneficial for certain individuals include acupuncture, massage, transcutaneous electrical nerve stimulation, and heat and ice therapy.[7] For the patient with deformity, the use of orthoses should also be considered, with care taken to pad bony prominences to prevent skin abrasions.[9] Walking and low-impact exercise are encouraged, because they may help prevent the progression of osteoporosis in elderly persons.[15]

There have been few randomized, controlled trials comparing conservative and surgical treatment for spinal disability. The Spine Patient Outcomes Research Trial (SPORT)[16] compared nonoperative care with decompression with or without fusion for lumbar spondylolisthesis with stenosis in a randomized and observational cohort simultaneously. Like many surgical trials, this study had large amounts of missing data and crossovers (up to 40% in the randomized cohort). The authors report in their as-treated analysis that surgery was significantly superior to conservative treatment in pain reduction and functional improvement at 2-year follow-up, although the as-treated analysis loses protection from confounding conferred by randomization, and the intention-to-treat analysis showed no significant differences between the two groups. The surgical and nonoperative groups both improved, and there was little evidence of harm from either treatment. A second SPORT[17,18] found similar results for patients with lumbar disc herniations. Another randomized, controlled trial comparing surgical with conservative treatment for lumbar spinal stenosis demonstrated significantly greater improvements in back pain, leg pain, and disability in subjects treated surgically.[19] The differences tended to decrease over time but were still significant at 2-year follow-up.

Unfortunately, there are even fewer data regarding nonoperative treatment in the geriatric population. One study of outcomes of nonoperative treatment for spinal stenosis found that age was predictive of a poor outcome.[20] Another reported a series of 33 patients aged 65 and older presenting with lumbar stenosis who were offered a structured conservative treatment plan.[21] After 6 to 10 months, 92% of the patients were not satisfied with their results. In another study of 263 patients aged 70 and older who underwent a 2-week intensive in-hospital conservative treatment program for their lumbar spinal stenosis, 140 eventually underwent surgery during the same hospital stay, and the authors prospectively followed the remaining patients for at least 2 years.[22] At the end of the 2-year follow-up, only 34.8% of patients reported improved subjective symptoms compared with time of discharge from the 2-week in-hospital treatment program, and only 39.4% rated themselves as good to excellent at ADLs. Complete block on CT myelography was prognostic for the worse outcomes. Last, in a prospective observational cohort trial with 10-year follow-up comparing the effects of surgical and nonsurgical treatment, surgically treated patients reported greater satisfaction and more improvement in symptoms and functional status, although the relative benefit of surgery decreased over time.[23] Although it is difficult to reach definitive conclusions from these nonrandomized studies, there is insufficient evidence to conclude that chronic pain or dysfunction due to lumbar spine disease can be successfully treated with a nonoperative regimen in elderly patients.

SPINE SURGERY

In general, surgery for degenerative conditions of the spine should be reserved for patients who have failed extensive nonsurgical interventions or who present with accompanying neurological deficits and progressively worsening symptoms. In addition to the greater surgical risks due to age and comorbidities,[24] spinal surgery presents a further challenge, because cases are often long, have large amounts of blood loss, necessitate extended hospital stays, and frequently require revision surgery later in life. In addition, poor bone quality predisposes older patients to vertebral fractures and the onset and progression of spinal deformity after any spinal surgical procedure. Thus, in the setting of osteoporosis, older patients often require more-aggressive surgeries to prevent further injury, thereby imposing additional surgical risk on the elderly patient.

COMPLICATIONS

Literature Review

A systematic review of the perioperative complication rates of lumbar spine surgery in elderly people was conducted. Case reports ($\leq$4 cases), reviews, articles reporting only specific types of complications (e.g., cardiac or instrumentation related), studies that included patients younger than 60, and articles not in English were excluded. A MEDLINE search using the terms "elderly," "complication," lumbar," "spine," and "surgery" through December 31, 2007, identified 467 articles, of which 432 were excluded based on title or abstract alone. Full-text review resulted in the exclusion of 15 other articles for various reasons (6, complication rates not reported; 4, minimum age younger than 60; 2, only specific complications included; 2, previously published data; 1, review article). Along with seven articles identified through review of reference lists, 27 articles met all inclusion criteria.

Table 1 summarizes morbidity associated with spine surgery in elderly people as currently reported in the literature. Complication was defined as any event for which the patient required a specific intervention. When not described by the study authors, a classification scheme previously developed[38] was used in which complications were designated as intraoperative or postoperative. Postoperative complications were further classified as major (adversely affecting the recovery of the patient) and minor (recorded in the medical chart but did not alter the recovery of the patients). In general, the quality of the current literature is poor, with small retrospective cohort studies and clinical case series representing the majority of studies. Blinded, randomized, controlled trials, or at least stringent, well-controlled prospective studies, are needed to accurately determine the safety of lumbar spinal operations in older adults.

Decompression

Complication rates in elderly patients range from 2.5% to 80%, although differences in patient populations, indications for surgery, and operative details, as well as variations in the definition of "complication" make comparison of these data difficult. Perhaps, the best-studied spinal procedure in elderly people is decompression for lumbar spinal stenosis. One study reported 258 consecutive cases of lum-

Table 1. Studies Reporting Complications in Elderly Patients

Source	Mean Age (Range)	Sample Size, n	Mean Follow-Up, Months	Diagnosis	Procedure(s)	Instrumented, %	Total Complications*	Major Complications	Minor Complications	Intraoperative Complications	Predictive of Complications	Reoperation	Mortality†
						%						%	
25	74.9 (70–?)	143	34.3	HNP, Stenosis	D, L	—	—	6.9	—	—	—	—	0
26	76.0 (70–93)	89	27.1	HNP, stenosis	D, L	—	25.8	6.7	12.4	4.5	Comorbidities	2.2	1.1
27‡	N/A (65–?)	18,122	—	Multiple	D, L, F	—	15.6	—	—	—	Age; L and F (compared with D)	—	0.3
28‡	72.0 (59–97)	27,111	48	Multiple	D, L, F	—	—	8.1	—	—	Fusion; prior spine surgery	10.3	0.7
29	72.2 (65–81)	31	42	Listhesis, stenosis	L	—	—	9.7	—	—	—	—	0
30	N/A (71–84)	50	24	HNP, stenosis	D, L	—	10.0	4	4	2	—	4	0
31‡	73.6 (65–?)	18,655	—	Stenosis	D, L, F	—	—	2.8	—	—	Age; fusion; comorbidities	—	1
32	65.5 (60–?)	60	78	HNP	D	—	—	3.1	0	1.5	—	20	0
33	73.8 (60–90)	38	—	Multiple	L, F	100	—	15	17.5	17.5	Female sex	—	0
34	78.0 (75–?)	65	19.6	Stenosis	D, L, F	76.1	30	9.9	26.8	1.4	—	7	0
35	76.5 (70–?)	68	42	Multiple	D, L, F	20.6	40	7.2	32.3	9.2	Fusion	5.9	1.5
36	78.8 (75–89)	122	45.7	Stenosis	L	—	26.8	9	16.4	—	—	—	0
37	72.2 (65–90)	235	41.5	Stenosis	D, L	—	43.1	12.8	30.4	—	—	9.4	0
38	72.0 (65–84)	98	—	Stenosis, listhesis, scoliosis	L, F	100	80	21.4	70.4	5.1	Age; levels; operative time	≥10	2
39	74.0 (70–101)	118	84	Stenosis	L, F	2.5	20.3	1.7	9.3	9.3	None	—	0
40	N/A (75–88)	88	21	Stenosis, listhesis, scoliosis	L, F	14.8	35.2	12.5	21.6	13.6	Comorbidities; operative time	—	0
41	71.5 (65–?)	124	40.3	Stenosis	L	—	38; 67§	9.7; 16.1§	25.8; 38.7§	—	—	11.3	0
42	73.0 (65–91)	44	11.9	Multiple	L, F	93.8	12.5	—	—	—	None	3.1	0
43	63.0 (61–71)	22	34.6	Degenerative disc disease	Total disc replacement	—	18.2	—	—	0	—	9.1	0
44	74.0 (70–77)	31	50	Listhesis	Posterior lumbar interbody fusion	100	—	16.1	—	—	—	—	0
45	N/A (80–?)	20	30.8	Multiple	L, F	75	—	35	30	—	Comorbidities	—	0
46	73.2 (65–92)	243	55.2	HNP, stenosis	D, L	—	2.5	1.2	0.8	0.4	—	—	0
47	73.3 (65–N/A)	166	—	Stenosis, listhesis, scoliosis	L, F	45	50.6	3	30.1	17.5	Levels	—	0
48	66.8 (6–85)	46	50.4	Scoliosis	F	100	37	19.6	30.4	23.9	Age; pedicle subtraction osteotomy	32.6	2.2
49	72.1 (65–85)	85	33.0	Multiple	F	—	31.8	—	—	8.4	—	16.5	0
50	80.8 (75–97)	50	10	—	D, L (minimally invasive)	—	0	0	26.3	5.3	—	1.8	0
51	86.6 (82–90)	25	36.8	Stenosis	D, L	—	52.0	12.0	—	0	—	4.0	0

* Total complication rate includes intraoperative and major and minor postoperative complications when available. May not be simple sum of three components, because patients may have had more than one complication. Definition of complication may differ between studies.

† Mortality rate includes deaths associated with operation or during same hospital stay.

‡ Large registry studies may have underreported complication rates, because some complications may have been coded incorrectly or not at all.

§ Rates are for patients without and with diabetes mellitus, respectively.

HNP = herniated nucleus pulposus; D = discectomy; L = laminectomy and decompression; F = fusion.

bar laminectomy for stenosis and found no differences in complication rate between age groups.[52] Another study of all spine procedures in the state of Washington using Medicare claims found a complication rate of 9.8% in those undergoing surgical decompression.[28] This was similar to the 6.9% found in a study of 143 patients undergoing discectomy and decompression[25] and the 9.7% in another study.[29] A study that matched 68 patients aged 65 to 80 undergoing decompression for spinal stenosis with a similar group undergoing total hip arthroplasty found that the incidence of major complications was similar between the two groups, although the patients with stenosis incurred more minor complications.[53] Most recently, in a report on 243 elderly patients undergoing outpatient decompression procedures, 10 (4.1%) had to be converted to an inpatient procedure because of complications, and of the remaining 233, there was only a 1.7% complication rate.[46] A study of patients aged 75 and older reported a much higher total complication rate (35.2%), with a major complication rate of 12.5%, and found that the Charlson Comorbidity Index was predictive of a perioperative complication;[40] this finding has been corroborated in other studies as well.[26,54] Not surprisingly, elderly patients with diabetes mellitus have been found to have nearly twice the complication rate for lumbar decompression as those without diabetes mellitus.[41] Although surgery for lumbar stenosis now appears to be a safe procedure in elderly patients, careful preoperative assessment of comorbidities and overall health status remains critical.

Spinal Fusion

Early investigators believed that the addition of an arthrodesis would lead to more complications in elderly patients.[27–29] Although one study found that the addition of fusion to lumbar surgery nearly doubled the in-hospital complication rate and increased hospital stay, operative time, total costs, and 6-week mortality,[28] whether fusion is riskier in elderly patients than in their younger counterparts using modern spine fusion techniques is more controversial. One study found no differences in complication rates in a comparison of older and younger patients undergoing pedicle screw fixation and posterior lumbar interbody fusion (PLIF), although older patients had longer hospital stays.[42] A second group also studied PLIF in elderly patients compared to a younger control group and found no differences in complications, although older patients tended to have a higher rate of delayed or collapsed union.[44] Recently, a study of posterior lumbar decompression and fusion (PLDF) with and without instrumentation found no significant differences in complication rate with the addition of instrumentation and, using historical data, no differences in comparison with younger patients.[47] Alternatively, a study of 98 patients aged 65 and older undergoing PLDF found an 80% overall morbidity rate, with 21.4% of patients experiencing a major complication.[38] It is unclear why that series[38] had such a high complication rate, although one theory attributes it to less-aggressive blood transfusions, which has been suggested to decrease medical complications.[39,47] For spinal arthrodesis, most investigators have not found that the presence or number of comorbidities predict a complication.[35,38,39,42,47]

Increasingly, elderly patients are requiring multilevel spine procedures, although several reports have now suggested a greater risk of complication for these types of surgeries in older patients.[38,47] For example, one study found that fusion of four or more segments was associated with the occurrence of a major complication in patients aged 65 and older.[47] More recently, a study of 46 patients aged 60 and older who underwent a minimum five-level fusions for adult spinal deformity found an overall complication rate of 37.0%, with a major complication rate of 19.6%.[48]

Patients Aged 80 and Older

One question that remains for the spine surgeon is, "How old is too old?" Investigators have found that patients aged 80 and older experience a dramatic increase in morbidity and mortality when undergoing spine surgery, with mortality approaching 10%.[52,28] Recently, a study of spinal fusion in 20 patients aged 80 and older found a 35% major complication rate, which is significantly higher than reported rates in younger geriatric patients undergoing similar procedures (Table 1).[45] Additionally, they reported that, in this age group, the odds ratio for incurring a complication was 9.2 for a medical comorbidity. Other studies have suggested a greater risk of complication in patients in their ninth decade.[28,31] Although higher-quality studies will be needed to begin to exclude patients based on age alone, factors such as comorbidities, overall health status, preoperative expectations, aggressiveness of the surgery, and life expectancy are especially important in this age group, and patients should be counseled about the increased risk of perioperative morbidity and mortality.

The development of less-invasive approaches to the spine may permit future surgeons to care for people of all ages. For instance, a series of 50 patients with a mean age of 81 undergoing minimally invasive lumbar decompression had no major complications or mortality.[50] Although the follow-up was short, patients aged 80 and older experienced the greatest improvements in symptoms. This presents an exciting avenue for further clinical research.

CLINICAL OUTCOMES

Literature Review

To assess clinical outcomes of lumbar spine surgery in elderly patients, a systematic review was performed. A MEDLINE search of the literature through December 31, 2007, using the search terms "elderly," lumbar," "surgery," and "outcome" produced 1,279 articles. Case reports ($\leq$4 cases), reviews, studies including patients younger than 60, those without description of follow-up methods, and articles not in English were excluded; 1,232 were excluded based on title and abstract alone. Full-text review of the remaining 46 studies resulted in 25 that met all inclusion criteria (Table 2).

The quality of the data as they relate to clinical outcomes in elderly patients undergoing lumbar spine surgery is poor. Of the 25 studies that met inclusion criteria, none were randomized, controlled trials, the majority were case series, and only five (20.0%) included younger control groups. Only 14 of the 25 (56.0%) used standardized outcome measures in their study design, and this number is

Table 2. Studies Reporting Clinical Outcomes in Elderly Patients

Source	Mean Age (Range)	Sample Size, n	Mean Follow-Up, Months	Response Rate, %	Diagnosis	Procedure	Outcome Measure(s)	Excellent	Good	Fair	Poor	Mean Improvement from Baseline	Predictive of Poor Outcome
								%					
25	74.9 (70–?)	111	34.3	69.2	Stenosis	D, L	Symptom improvement	—	72	18	10	—	None
26	76.0 (70–93)	89	27.1	94.3	HNP, stenosis	D, L	Pain and ADL survey	—	31.4	51.4	17.1	—	—
29	72.2 (65–81)	34	42	91.1	Listhesis, stenosis	L	Symptom improvement	64.5	16.1	—	19.4	—	—
30	N/A (71–84)	50	24	92	HNP, stenosis	D, L	Leg and back pain relief	Leg 60.9; back 54.3	—	Leg 19.6; back 20.0	Leg 19.6; back 25.7	—	—
55	68.2 (60–89)	34	37	100	Stenosis	L, F	Symptom improvement leg and back JOA	29.4	23.5	23.5	23.5	Leg 31.1*; back 53.0*	—
32	65.5 (60–?)	60	78	84	HNP	D	Leg and back pain improvement	—	—	—	—	Leg 91.0; back 58.0	Complication; multiple levels
33	73.8 (60–90)	38	—	78.9	Multiple	L, F	Satisfaction; VAS	—	56.7	26.7	16.7	64	—
34	78.0 (75–?)	65	19.6	93.8	Stenosis	D, L, F	Leg and back pain relief	—	Leg 79.4; back 65.5	Leg 7.9; back 17.2	Leg 6.3; back 19.0	—	—
35	76.5 (70–?)	68	42	65	Multiple	D, L, F	Symptom improvement	—	60	19	21	—	—
56	68.2 (60–85)	10	—	100	HNP	—	JOA	—	—	—	—	82.6*	—
57	70.0 (60–85)	83	35.8	100	Multiple	L, F	Modified low back outcome score	54	29	7	10	—	Degenerative joint disease, prior surgery
37	72.2 (65–90)	235	41.5	83.2	Stenosis	D, L	Satisfaction	18.6	48.5	19.6	14.1	—	None
58	70.2 (65–75)	12	21.6	100	HNP	D, L	JOA	—	—	—	—	73.7*	—
39	74.0 (70–101)	118	84	100	Stenosis	L, F	Chart review	50.8	41.5	4.2	3.4	—	—
40	N/A (75–88)	88	21	—	Stenosis, listhesis, scoliosis	L, F	Leg and back pain survey	Leg 43.0; back 43.0	Leg 42.0; back 33.0	—	Leg 15.0; back 24.0	—	—
41	71.5 (65–?)	124	40.3	—	Stenosis	L	VAS; ADLs	—	—	—	—	VAS 58.8; ADLs 15.9	—
59	82.2 (80–?)	23	32.4	82.6	Stenosis	L	VAS	—	—	—	—	54.1	Musculoskeletal comorbidity
43	63.0 (61–71)	22	24	100	DDD	Total disc replacement	Satisfaction; ODI; VAS	14	80	—	6	ODI 46.9; VAS 50.6	—
60	71.4 (65–?)	367	41.6	81	Stenosis	—	VAS; Barthel	—	—	—	—	VAS 57.5; Barthel 21.7	None
44	74.0 (70–77)	31	50		Listhesis	Posterior lumbar interbody fusion	JOA	—	—	—	—	63.0*	—
46	73.2 (65–92)	243	55.2	57.8	HNP, stenosis	D, L	Satisfaction; VAS	27.2	41.9	14.7	16.2	VAS 79.5	—
48	66.8 (60–85)	46	50.4	100	Scoliosis	F	ODI	—	—	—	—	49	None
49	72.1 (65–85)	85	33.0	100	Multiple	F	ODI; SF-36	—	—	—	—	ODI 32.9; SF-36 18.1	Prior surgery
50	80.8 (75–97)	50	10	74.0–100.0	—	D, L (MI)	Leg and back VAS; ODI; SF-36	—	—	—	—	Leg 59.6; back 61.4; ODI 43.8; SF-36 58.8	†
51	84.0 (80–91)	39	36.8	64.1	Stenosis	D, L	VAS; Barthel	—	—	—	—	VAS 53.6; Barthel 18.4	—

* Rate of recovery based on Japanese Orthopedic Association (JOA) (pain) score.[44]

† Predictive of positive outcome: aged ≥80; single-level surgery.

HNP = herniated nucleus pulposus; D = discectomy; L = laminectomy and decompression; F = fusion; JOA = Japanese Orthopedic Association (pain); VAS = visual analog scale (pain); ADL = activity of daily living; ODI = Oswestry disability index (back pain); SF-36 = 36-item Medical Outcomes Study Short-Form Survey (physical and mental health); DDD = degenerative disc disease.

reduced to eight of 25 (32.0%) if the visual analog scale is not included. In addition, only six studies (24.0%) contained more than 100 patients, and only eight (32.0%) analyzed potential prognostic factors for good or poor outcomes. With the number of spinal procedures in elderly patients predicted to increase, better-designed studies on the clinical efficacy of these operations is needed.

Outcomes After Surgery

Studies reporting good or excellent outcomes in elderly patients undergoing spine surgery vary between 53 and 93% depending on length of follow-up, patient population, surgical indication, and procedural details (Table 2). Early studies demonstrated that elderly patients undergoing simple decompression for stenosis fared no worse than young people at intermediate-term follow-up.[25,26,29,30] For example, one study showed at 2-year follow-up that 74.3% and 80.4% of their patients aged 70 and older had good or excellent outcomes in terms of their lower back and leg pain, respectively,[30] although a recent study of outpatient procedures for spinal stenosis with an average of 4.6 years of follow-up reported a good or better outcome in only 69.1% of patients aged 65 and older.[46] Another study demonstrated a 54.1% improvement in Oswestry Disability Index (ODI) scores, a standardized measure for rating low back pain, as well as significant decreases in analgesic usage in patients aged 80 and older undergoing laminectomy for spinal stenosis at mean of 2.7 years of follow-up.[59]

The addition of an arthrodesis is thought to be associated with better outcomes. While controversial when used for stenosis alone, this is especially true when used for stenosis with spondylolisthesis.[61] However, one study reported on 118 patients aged 70 and older with stenosis, spondylolisthesis, or both and found no differences in clinical outcomes with a mean 7 years of follow-up between patients receiving decompression alone (93.1%) and those receiving decompression combined with fusion (91.1%).[39] Another study of the effects of age on outcomes of PLIF for degenerative lumbar spondylolisthesis, using the Japanese Orthopedic Association (JOA) scoring system, which includes subjective ratings of pain and function, as well as objective physical examination findings, found that patients aged 70 and older had slightly less, though significant, clinical improvement (63%) at a mean 4.2 years of follow-up than patients younger than 70 (70%).[44] Few clinical data are available for elderly patients requiring surgery for other conditions, such as degenerative scoliosis, vertebral fractures, infections, or malignancies of the spine. Although the literature indicates that older patients do as well as their younger counterparts after spine surgery, all patients should be counseled about the relatively common risk for a poor outcome.

RADIOGRAPHIC EVALUATION

Poor bone quality presents a significant challenge for successful spinal fusion, because it increases the risk of hardware failure, adjacent segment degeneration, and compression fractures. Multiple points of fixation, augmentation of pedicle screws, and iliac fixation have enhanced the fusion capability of the osteoporotic spine.[9] Routine radiographic follow-up at regular intervals is critical for confirming a solid bony fusion. Although plain flexion–extension x-rays may be substandard in evaluating fusion, other alternatives, such as CT, can be expensive, involve large doses of radiation, and have not been proven to be significantly superior. No technique short of surgical exploration is perfect for evaluating fusion status; therefore, in the asymptomatic patient, periodic follow-up with flexion–extension radiographs appears appropriate.[62]

Unfortunately, little information is available regarding fusion rates in elderly patients. In one study a radiographic evaluation performed using CT in patients aged 70 and older undergoing posterior lumbar interbody fusion found that they had higher rates of collapsed union and delayed union than patients younger than 70.[44] Another study of the effects of age on outcomes of surgery for adult idiopathic scoliosis found that, although pain relief was more consistently obtained, radiographic results (correction in sagital and coronal planes) were inferior in older people than in their younger counterparts.[63] Older persons are susceptible to instrumentation-related complications, and thus regular follow-up of patients undergoing instrumented fusion is necessary.

CONCLUSION

Symptomatic spinal stenosis, spondylolisthesis, degenerative scoliosis, and vertebral fractures are conditions that can cause disabling pain or neuropathy in elderly patients. In a nonemergency setting, nonoperative therapies, including physical therapy, corticosteroid injections, opioid analgesia, epidural corticosteroid injections, image-guided minimally invasive procedures, and bracing, should be used before surgical treatment is considered. The surgical treatment of symptomatic spinal disorders is challenging in any patient population. Medical comorbidities, osteoporosis, and age-associated changes in cognition can increase the risk for perioperative complications in the elderly population after spinal surgery. Preoperative risk assessment, an appropriate surgical approach, and postoperative physical therapy are crucial to successful outcomes after any spinal surgery, even nonfusion procedures. Although clinical case series and state-wide or national registry studies[27,28,31] indicate a slightly higher risk of perioperative complications in older patients, cohort studies that have included younger control groups have failed to show significant differences.[42,44] Clinical outcomes, in terms of satisfaction after surgery, as well as pain and functional improvement, appear to be similar in elderly patients and younger ones. However, the quality of the evidence as it stands is poor, and randomized, controlled trials or well-controlled prospective cohort studies are needed to more accurately determine the complication risk and efficacy of lumbar spine surgery in elderly patients. As of now, age should not be an independent exclusion factor, and the decision to proceed with spinal decompression or fusion in any patient should be made on a case-by-case basis.

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