

# Adult Spinal Deformity: Contemporary Treatment and Patient Outcomes

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## ABSTRACT

The incidence of symptomatic adult spinal deformity (ASD) is increasing due to aging of the population, iatrogenic factors, and an increasingly active elderly population. Spinal deformity in the adult population can produce major functional disability. Patients with less severe forms of ASD can generally be managed without operative intervention. For those individuals with disabling pain, functional impairment, or progressive spinal malalignment, surgical treatment is available and effective. However, the surgery is complex and associated with a significant risk of perioperative complications. Efficacy and safety is optimal when operative intervention is performed by a surgical team (and hospital system) experienced in the management of complex spinal pathology. Quality of life for the ASD patient can be greatly improved with proper patient selection, technical execution, and perioperative care.

## INTRODUCTION

Adult spinal deformity (ASD) is caused by malalignment of the thoracic or lumbar spine which results in varying degrees of back pain, radicular leg pain, torso deformity, activity limitation, and social stigma due to abnormal posture. ASD becomes increasingly common with advancing age and is an underappreciated cause of disability in the elderly population. The United States Census Bureau estimates that the population aged 65 and over will increase from 13% in 2010 to 20% in 2030.<sup>1</sup> Schwab *et al* found that 68% of asymptomatic volunteers over the age of 60 had degenerative scoliosis.<sup>2</sup> It is expected that the number of patients suffering from degenerative spinal disorders, particularly adult spinal deformity (ASD), will follow a similar trend. Increasing patient expectations for maintenance of function in later years will require effective nonsurgical and surgical strategies for management of ASD.

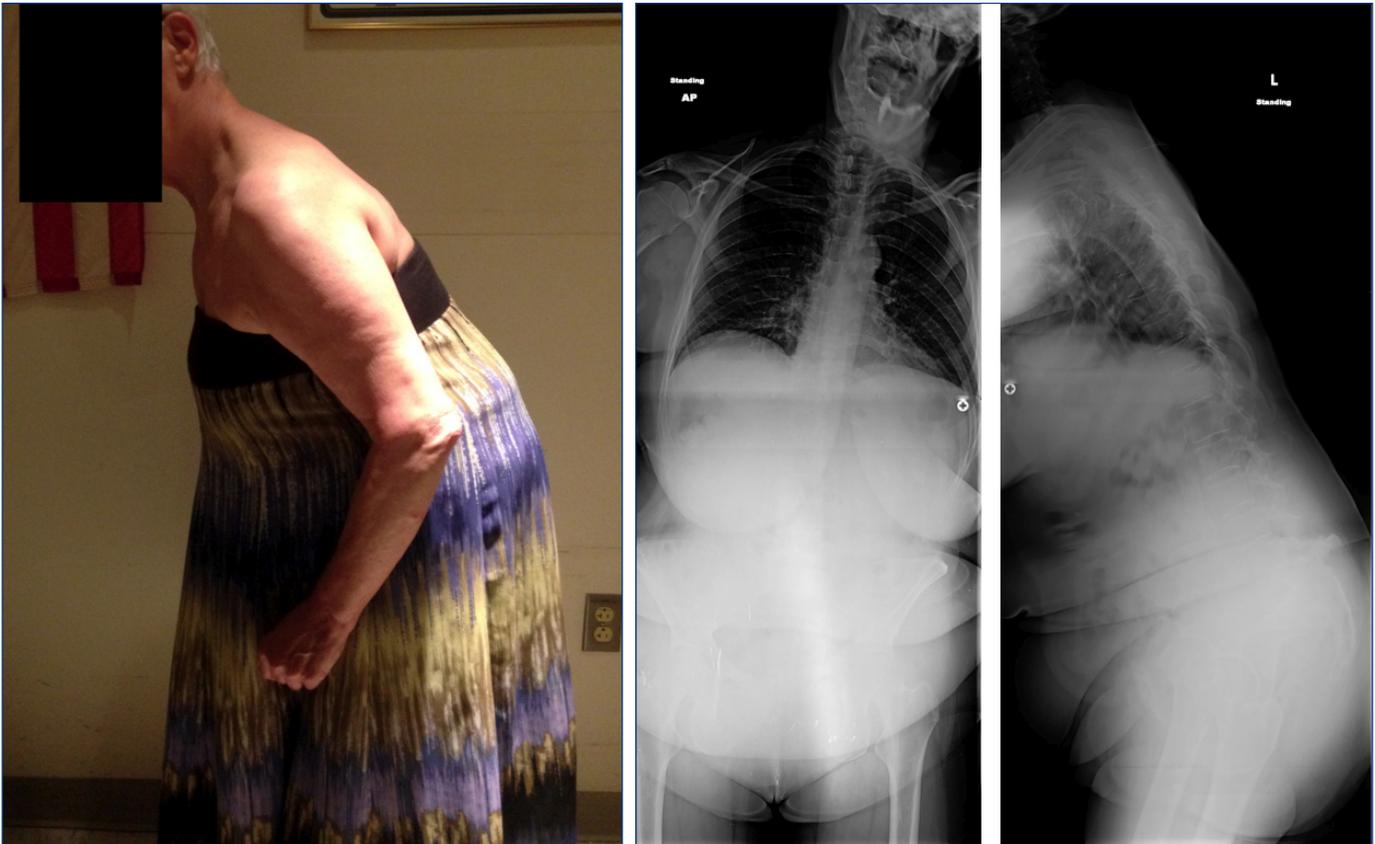
Patients with ASD can have scoliosis (a curvature on the anteroposterior radiograph), kyphosis (forward curvature on lateral radiograph), positive sagittal balance (whole torso leaning forward), and spinal and neuroforaminal stenosis (decreased space available for the neural elements). Degenerative scoliosis often leads to spinal and neuroforaminal

stenosis which may lead to back and leg pain and walking intolerance, and may also cause a deformed appearance of the torso. Left untreated, pulmonary dysfunction may occur, although this is uncommon. Kyphosis and positive sagittal balance cause the body's center of gravity to move forward in space, which can cause severe exhaustion with ambulation and disabling pain. ASD patients, especially those with positive sagittal balance, often suffer significant disability.<sup>3</sup> The quality of life for adults with spinal deformity has been assessed in multiple studies utilizing instruments such as the Scoliosis Research Society Outcomes Instrument (SRS-22).<sup>4,5</sup> Baldus *et al*<sup>4</sup> found that ASD patients report functional limitations, increased pain and increased use of analgesic medications. ASD patients are often limited to light work and household chores, while unaffected adults can participate in sports and perform heavier work.<sup>5</sup> Berven *et al* found that ASD patients are more likely than non-ASD individuals to suffer from anxiety and depression, which may be related to increased pain.<sup>5</sup>

While non-operative treatment modalities are the appropriate initial option, these measures provide limited benefit in the setting of disabling pain or progressive spinal malalignment. Furthermore, there is limited supportive data regarding the efficacy of conservative care for ASD patients.<sup>6</sup> The most commonly prescribed conservative therapies include bracing, physical therapy, injections, and chiropractic manipulation.<sup>6</sup> External orthoses have been utilized but provide only modest short-term relief.<sup>7</sup> While Barrios *et al*<sup>8</sup> documented significant pain relief in ASD patients treated with physiotherapy, these results have been difficult to reproduce. There is limited evidence in support of chiropractic care for ASD.<sup>6</sup> Transforaminal corticosteroid injections have been shown to provide some benefit, but only in patients with true radicular pain.<sup>9</sup>

A study by Glassman *et al* demonstrated that, despite questionable benefit, non-operative resources are frequently utilized by patients with ASD.<sup>3</sup> The authors divided 585 non-surgical ASD patients into high-symptom and low-symptom groups based on an Oswestry Disability Index (ODI) score of greater or less than 20 respectively. Symptoms of ASD reported on the ODI include limitations in personal care, lifting, walking, sitting, standing, sleeping, sex life, social life, and travelling due to back pain. Eighty-eight per cent of high-symptom patients and 70% of low-symptom patients reported recent treatment for ASD symptoms including

**Figure 1a:** Elderly female with coronal malalignment and positive sagittal balance – note forward posture on photograph and lateral radiograph.



**Figure 1b:** [Images at right] Improved coronal and sagittal spinal balance following spinal osteotomy.

narcotics, physiotherapy and pain management referral. Though high-symptom patients were more likely to require injections and pain management, low-symptom patients also demonstrated substantial use of resources.

### OPERATIVE TREATMENT OF ADULT SPINAL DEFORMITY

Advances in pre-operative optimization, operative techniques and perioperative management have made surgical intervention a reasonable alternative for an increasing number of patients.<sup>10,11</sup> Multiple investigators have reported substantial benefit of surgery with respect to pain, self-image, function, and ability to perform physical activities. These benefits have been demonstrated despite the complexity of spinal realignment procedures and a substantial perioperative complication rate.<sup>10</sup>

Surgery for adult spinal deformity most often includes posterior spinal instrumentation with pedicle screws and rods to fixate the spine with an improved posture, with bone graft placed to achieve bony fusion. Spinal osteotomy may be required to



realign the spine for severe deformities, which add complexity and complication risk to the surgery. Additionally, anterior or lateral spinal approaches for fusion may be indicated to help improve the chance of operative success. Decompression is added to the procedure when stenosis is symptomatic.

There is a large body of evidence demonstrating positive mid- to long-term outcomes following surgical intervention for ASD.<sup>10,12-14</sup> Yadla et al. found that operative intervention for adult spinal deformity is associated with improvement in both radiographic and clinical outcomes at a minimum 2-year follow-up.<sup>11</sup> Paulus et al. assessed health-related quality of life outcomes for non-operative and surgical treatment of ASD; conservative care provided no measurable benefit while surgery improved quality of life measures, pain, and disability due to back pain as measured by the ODI at 2- to 5-year follow-up.<sup>14</sup> A recent investigation by Haque et al. in 2014 comparing different methods of surgical treatment documented success in maintaining improved spinal alignment and in decreasing patient symptoms.<sup>15</sup> A cost-effectiveness analysis performed by McCarthy et al. found that surgical treatment for ASD is also cost-effective after a 10-year period.<sup>16</sup>

The success rate of ASD surgery is related to careful patient selection, and is challenging to strictly define. Numerous studies have documented improved pain and function at 2-year follow-up with favorable outcomes than non-operatively treated ASD patients.<sup>14</sup> Dissatisfaction rates of up to 25% have been reported, although this data stems from surgical techniques which have since been largely abandoned due to unacceptable morbidity.<sup>17</sup> Postoperative complication rates of up to 50%, with major complication rates of over 13%<sup>14</sup> are an important factor when patients and surgeons are considering corrective surgery.

It is important to recognize that the evidence supporting successful outcomes for surgical treatment of ASD emanates from tertiary referral spine centers. Increased surgeon experience and hospital staff familiarity associated with increased volume is essential to ensuring a consistently positive surgical outcome. A recent study by Paul et al. assessed the complication rates, length of stay (LOS) and hospital charges for patients with adolescent spinal deformity treated with spinal arthrodesis by surgeons across a range of annual case volumes.<sup>18</sup> The authors concluded that patients treated by higher volume surgeons experienced fewer complications and had shorter LOS.<sup>18</sup> It is logical to assume that the results of Paul et al. can be extrapolated to the adult spinal deformity population.

**Figure 2:** 3D reconstruction of severely deformed spine, printed for surgical planning.



### ADVANCED TECHNOLOGY

Advances in diagnostic imaging and surgical technology have improved the safety profile of adult spinal deformity procedures. The generation of three-dimensional radiologic images of the spinal column allows for more precise pre-operative planning (**Figure 2**). Computer navigation during surgery allows the insertion of spinal fixation devices with greater accuracy and less radiation exposure to the patient.

The role of minimally invasive (MIS) techniques for ASD is expanding. Although most patients with severe spinal deformity require traditional open posterior spinal surgery, several less invasive surgical options are now in use. In a recent study by Haque et al., the results of open surgery were compared to MIS and hybrid approaches: while all techniques resulted in similar functional outcomes, complications were lowest with MIS and hybrid approaches.<sup>15</sup>

**Figure 3:** Anteroposterior and lateral radiographs revealing adult spinal deformity patient pre- and post-operatively with correction of curve magnitude.



## DISCUSSION

Adult spinal deformity is a disabling condition which will increase in incidence in the coming years. Advances in pre-operative planning, operative techniques, and perioperative care have improved the outcomes of ASD patients following surgical correction (**Figure 3**). Despite largely positive outcomes, surgical complications are still common. To optimize the outcomes of adult spinal deformity patients, careful patient selection and operative care by an experienced surgical team is mandatory.

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