

Spine fusion and Adjacent Segment Disease

Adjacent Segment Disease (AKA ASD, Adjacent Level Disease, ALD) following spinal fusion is one of the most common long-term consequences of spinal fusion and one of the greatest challenges facing spine surgeons and their patients. So, what is ASD and why is it so concerning? ASD is degeneration of the joints above and/or below the level of the fusion(s). It is the result of biomechanical changes that take place after a spinal motor unit no longer has motion and the forces previously accommodated by that joint are transferred primarily to the motor units above and/or below. The ASD often results in the need for reoperation and has a domino effect over time as more segments develop ASD progressively. For clarification, a motor unit in the spine consists of two adjacent vertebra and all the connective tissue structures between them. The specific joints of a spinal motor unit include the disc and the two facet joints.



When a fusion is performed by a spine surgeon the purpose is to remove all movement between the selected levels. This is often done because of spinal instability or a number of other clinical indications such as central stenosis when it is believed that motion is the source of pain. Typically, cervical spine fusions have better long-term outcomes than do lumbar fusions, but both have the complication of ASD. Acknowledging ASD as a significant complication of spine surgery, researchers and spine surgeons have been investigating ways to maintain controlled motion in the spine using dynamic stabilization devices.

The most commonly used dynamic stabilization used these days is an artificial disc which is implanted during disc arthroplasty surgery. The designs of these artificial discs vary from company to company and there is much debate about which is best. Despite the logic of using motion sparing artificial discs, the majority of the current literature has not demonstrated statistically significant differences between fusion surgeries and implantation of artificial discs as it relates to the development of ASD. Much of this has to do with the ever evolving designs of the artificial disc as they try to duplicate the biomechanics of a normal healthy disc. This is no easy task and made particularly difficult considering the varying anatomy of patients and the multiple different spinal conditions contributing to the need for fusion or stabilization.

The question for lawyers to consider is the need for future surgeries at the adjacent levels. There is no clear answer to this, and the data is all over the place in the literature. I recently read a retrospective study from a neurosurgery journal that reviewed 131 patients who underwent L4-5 fusion for degenerative joint disease over a 10 year period using a posterior pedicle screw construct with or without interbody fusion. The study defined ASD as degenerative disease requiring reoperation above

or below the level of fusion. The study found that the reoperation rate was 25.2%. Twenty-four cases (18.3%) of surgery at the level above. Three cases (2.3%) required surgery at the level below. Six cases (4.6%) required surgery above and below the fused segments. In my experience with patients (and my father), those numbers seem relatively low, particularly in the lumbar spine. In my father's case, he required reoperation and revision surgeries every two years until he ultimately could not get another surgery and was essentially non-ambulatory for the remainder of his life.

The takeaway for lawyers representing patients that ultimately require a spinal fusion is that there is a high incidence of ASD and the need for reoperation. This must be considered when settling or trying their client's case. With spine surgeries costing between \$100,000 and \$200,000 for an uninsured patient paying out of pocket, the physical impact of their injuries is compounded by the financial consequences.

As I was writing the above newsletter I also posted a related question on LinkedIn. Below is the question and the responses to date from spine surgeons around the world. To see the original post on LinkedIn [click here](#).

My Question: Adjacent Segment Disease (ASD) question for my spine surgeon friends. A colleague asked for an opinion about the likelihood of an L4 fusion resulting in adjacent level disease in a 52-year-old male in otherwise good physical condition (non-smoker, athlete). My opinion was that the likelihood of ASD in his lifetime is probably 100% but the likelihood of the need for additional fusions at adjacent levels is multifactorial. He was told by the orthopedic spine surgeon that the need for surgery at the adjacent level was 15% and that seems extraordinarily low in my experience. I would think that 25% in 10 years and much higher as the patient ages and deconditions beyond that. Can anyone offer me some insight from their experience or from the literature? (reposted)

Here are the responses so far:

We published recently on this subject (ASD after L4/5 fusion). The mean fu was little under 8 years and the rate of ASD leading to reoperation was around 8-10%. Very large database actually and with patient reported outcome measures. <https://doi.org/10.1080/17453674.2021.1879505>

Reoperations after decompression with or without fusion for L4–5 spinal stenosis with or without degenerative spondylolisthesis: a study of 6,532 patients in Swespine, the national Swedish spine register Reoperations after decompression with or without fusion for L4–5 spina...<https://doi.org/10.1080/17453674.2021.1879505> [Background and purpose — There are different opinions](https://doi.org/10.1080/17453674.2021.1879505)

Great question sir

I agree I think 15% is low

One of the classic studies on this showed 36% at 10 years

<https://pubmed.ncbi.nlm.nih.gov/15252099/>

A newer study comparing MIS versus open fusion found similar rates of adjacent segment disease at 10 years - about 1 in 3 for both (surprising)

<https://pubmed.ncbi.nlm.nih.gov/34740178/>

For cervical fusion I will tell patients 1/5 at 10 years based on the Riew and Hillibrand studies

About half of that for cervical disc replacement

Hope that helps

Comparison of adjacent segment disease after minimally invasive versus open lumbar fusion: a minimum 10-year follow-up - PubMed

I usually use 10% for every 10 yrs. His L4,5 resulted in loss of lordosis that puts additional load on L3,4 facet

Studies result vary, I usually quote 15% in 15 years just to make it easier for patients to remember. I reality I hate to agree it's higher like you mentioned.

The classically quoted paper states 15% at 5yrs, and 35% at 10 yrs for single level OPEN lumbar fusion. This may be different with use of minimally invasive techniques, although that statement is speculative.

This particular patient has concerning radiographic features, as stated by someone else already, namely loss of L4-S1 lordosis which the modern deformity literature says should be roughly 35 degrees. This patient already has a retrolisthesis at L3-4 which may herald more issues in the future.

Lastly, I would say that reoperation rates are not necessarily the best outcome measure to evaluate surgical success vs failure. The decision to reoperate involves multiple stakeholders (ie: Does the surgeon want to reoperate, or feel comfortable with revisions? Does the patient want to go through

another surgery when the first one didn't provide durable results? Does the system allow for expedient care?) Be careful equating low reoperation rates with clinical success, this is a common pitfall.

Agreed. Not so clear cut. And this is getting into the weeds, but I had hoped that newer MIS data would showcase lower rates of ASD. But the latest literature suggests otherwise -- with the caveat that 10-year follow-up data intrinsically means that the patients being followed were treated potentially utilizing slightly outdated techniques / theoretical understandings from at least 10 years prior. And we know how much the science has advanced in the last 10 years alone. Ultimately, it seems surgical technique, sagittal alignment, lumbar harmony, along with patient specific factors like comorbs, lifestyle choices, as well as physical conditioning, all likely affect one's risk of developing symptomatic adjacent segment disease. It is not as simple as fusion versus no fusion. Hopefully, application of these modern day understandings and techniques to our patient's surgeries today will translate to lower rates of ASD in the future when compared to historical rates. And as one of the other commenters suggests, I think pushing for patient involvement in their back health is so huge. I tell my surgical patients that my job is easy, theirs is the hard one if they want to keep their back as healthy as possible moving forward.

Thank you for sharing this Dr Steven Shaw but as a medical device rep in the spine industry, I've asked my surgeons about this subject millions of times and the answer they gave me is always that there are so many variable depending on the initial spine problem, your age and bone health, and the number of levels fused. In general, the risk is 2-14% per year in the lumbar spine.

I personally would argue that the overall rate is what you describe but I frame it differently. I typically use those numbers for no proactive health maintenance and give them ways of reducing those risks. Best nutrition, weight optimization, agility and flexibility training, a solid aerobic fitness commitment, a traumatic core and torso maintenance program, smart vertical load decisions, and postural maintenance.

I have three groups in several thousand lumbar fusion patients and the group that adheres to proactive health is significantly less than 5%, particularly those who showed up with a single segment spondylolisthesis vs multilevel degenerative changes at principle event. To me that person should avoid fusion if at all possible.

L5-S1 = severe hypolordosis. L4-L5 = fixed in hypolordosis. Already compensating on L3-L4 (hyperlordosis for this level compared with the rest, 40% of lordosis should be on L5-S1, 27% on L4-L5). These biomechanical stresses will probably be a major factor in generating ASD for this patient I think.