Spine and Fusion

It has been more than a century since 1911 when Albee first used spinal fusion surgery to treat Pott’s disease and Hibbs used a fusion to treat a spinal deformity. In the past 50 years, spinal fusion surgery has been used to treat many diseases, including instability, trauma, infection, tumour, lumbar stenosis, degenerative spondylolisthesis, scoliosis, degenerative disc disease, facet syndrome and pseudoarthrosis. Because spinal fusion surgery was effective at resolving patient complaints, the long-term problems associated with the surgery were initially ignored by surgeons. For example, although the symptoms of serious spinal stenosis decrease after decompression, stabilisation and fusion, the long term outcome is unclear. As discussed elsewhere in this book, despite the prevalence of spinal fusion, it is important to realize that the same success is not observed in analysis.

An analysis of the increase in fusion surgery during the last 20 years causes one to reexamine surgical techniques that have been considered a ‘golden standard’.

Research in the USA has demonstrated that spinal surgery increased 77% between 1996 and 2001, whereas an increase of just 13-14% was observed for hip prosthesis and knee arthroplasty surgery in the same population during the same time period. The increase in spinal fusion surgeries may have resulted from the Food and Drug Administration’s approval of the use of interbody cages in 1996.

The first spinal fusion attempts were performed using bone grafts because the main purpose was to unify the bone structure. However, the process of fusing the bone structure and the required immobilization of the patient caused a need to create alternatives. Thus, spinal instruments made of metallic ingredients that were resistant to weight were created. In particular, transpedicular screw fixation became popular for use in treating spinal instability and degenerative diseases during the past 20 years. Many screw-rod and screw-plate systems have been used. In addition to metal implant development, synthetic bone grafts and many products containing growth factors have been used to shorten the time required for fusion.

Adjacent Segment Disease

The aim of decompression and fusion surgery is to overcome neurological symptoms, prevent new neurological deficits, and regain an active life that was lost due to severe pain. However, spinal fusion causes a deformity in the spine’s normal biomechanics. The loss of mobility in the fused areas is compensated for by non-fused areas. As a result, the facet joints adjacent to the fusion are under considerable stress. The degenerative symptoms observed in adjacent segments following fusion surgery include disc degeneration, disc hernia, degenerative spondylolisthesis, segmental instability, spinal stenosis, posterior facet joint degenerative arthritis. The collection of such symptoms observed in adjacent segments after fusion surgery is referred to as “adjacent segment disease”. (Figure 1)
Adjacent Segment Disease and Its Correlation with Clinical Symptoms

Patients believed to have adjacent segment disease usually go to clinics with complaints such as mechanic back pain, radicular pain and neurologic claudication. However, the clinical analyses of adjacent segment disease are paradoxical.

Lehmann and colleagues [4] followed 32 lumbosacral fusion patients for more than 30 years, and they reported that the probability of instability in the superior part of the fusion segment is 45%. Thirty-three percent of patients had stenosis at the inferior portion of the fusion segment; however, they reported that these segment degenerations were not correlated with clinical symptoms. Similar results were reported by Luke et al. [5] who diagnosed hypermobility in the adjacent spinal segments of 22 patients who had undergone a lumbosacral long segment fusion to treat adolescent idiopathic scoliosis. They found that these radiologic changes were not correlated with the clinical symptoms of the patients. In their study of degenerative disc disease patients, Kumar and his colleagues [6] compared 28 posterior fusion patients with 20 patients treated with non-fusion techniques. They observed two times more radiologic changes in the adjacent segments in the fusion patients than in the non-fusion group. However, no difference in the clinical or functional results was observed between the two patient groups.

Despite these reports, Rahm and Hall [7] reported that adjacent segment degeneration occurred in %35 of 49 patients who were followed up to 5 years after posterior lumbar instrumentation and fusion were applied. According to their research, age and the usage of interbody fusion are correlated with adjacent segment degeneration and are responsible for spinal deterioration over time. Furthermore, Rahm and Hall reported that a pseudoarthrosis complication has a conservative effect of the occurrence of adjacent segment degeneration.

In Etebar and Cahil’s study of patients who underwent spinal fusion to treat degenerative spinal instability, they reported that 18 of 125 patients (14%) developed symptomatic adjacent segment disease within 44.5 months post-surgery. [8] The observed adjacent segment diseases included spondylolisthesis (39%), disc herniation or spinal stenosis that results from facet hypertrophy (33%), corpus stress fractures (28%) and scoliosis (17%).

It is important for doctors, patients and those considering health economics to be aware of the risk factors that affect the incidence and increase of adjacent segment disease. This knowledge is also important.
to understand when considering the role of alternative non-fusion technologies. It is generally accepted that adjacent segment disease occurs in more than 30% of spinal fusion patients, and studies have shown that old age, menopause, obesity, the number of fusions, superior fusions (L1-L3), laminectomy and segmented lordosis are risk factors.

Nonfusion Dynamic Stabilisation

Research has demonstrated that after spinal fusion, the adjacent segments are exposed to increased stress, mobility, and disk pressure, as well as a change in movement across the back. Degeneration is observed in the segments adjacent to the fusion, but it is unclear whether the radiologic and clinical diagnosis of adjacent segment disease is the result of the spinal fusion or simply reflects the degenerative disease’s natural progress. Whatever the cause, it is important for clinicians, patients and economists to be aware of adjacent segment disease and what can be done to prevent it.

The concern regarding adjacent segment degeneration has accelerated the development of mobile protection systems as an alternative to spinal fusion. Huang and colleagues reported that adjacent segment disease occurred in 24 of 42 total disc prosthesis patients who were followed for up to 8.7 years, but the prevalence of radiologic adjacent segment degeneration decreased in patients who were mobilized more than 5 degrees. This report supports the idea that conserving the spinal range of motion protects against adjacent segment degeneration. Therefore, posterior dynamic or non-fusion stabilisation systems have been developed and are commonly used.

Lumber Hybrid Dynamic Stabilisation and Fusion

It is possible to encounter pathology at more than one disc level in patients complaining of back or leg pain. In the recent past, spinal surgeons have treated such patients using either fusion or non-fusion systems. However, each affected segment needs to be classified to appropriately treat patients with multisegmental disc disease. For example, an L4-L5-S1 fusion surgery can be accepted as an overtreatment for a patient who has L5-S1 instability and L4-L5 degenerative disc disease as well. However, performing only a L5-S1 fusion on such a patient and ignoring the L4-L5 degenerative disc disease may not provide an effective result. It is our opinion that for this type of patient, dynamic systems need to be used if an L5-S1 fusion is performed to obtain the optimal outcome for the patient (Figure 2 and 3).

Figure 2. 40-year-old woman with severe back pain
a) T2 MRI view. White arrow: L5- S1 spondylolisthesis, Red arrow: L4- L5 disc degeneration.

b) L5- S1 fusion segment (white arrow)
L4- L5 dynamic stabilisation (red arrow)
Therefore, it is possible to treat the pathologic segment and prevent further deterioration of the disc. This approach forms the primary philosophy of the “hybrid system”. As is discussed elsewhere in this book, a hybrid system combines stabilisation with a dynamic system to halt disc degeneration and support regeneration.

In the Neurosurgery Clinic in Ankara Atatürk Training and Research Hospital 1, 682 of the 1776 spinal surgery patients underwent decompression, posterior instrumentation and spinal fusion by the same surgery team between 2006 and 2010. Unfortunately, we are now seeing an increasing number of these patients develop “adjacent segment disease”. Although our study regarding the factors affecting the incidence of and the increase in adjacent segment disease has not yet been completed, our clinical and radiological results are consistent with those reported in the literature. In our study, the percent of patients who require further surgery due to symptomatic adjacent segment disease is similar to that reported in the literature.

We need to change our treatment plan in the last one year because of this late term complication of spinal fusion in our clinic. We have begun to use a hybrid system (B-Dyn, SL4, Implants, France) to apply dynamic stabilisation to the upper segment adjacent to the fusion where degenerative changes are observed [Figure 4]. However, we can only use this system in patients under the age of 45 because of insurance constraints. More time is needed to determine the ability of the hybrid system to prevent adjacent segment disease. We will be able to share our results as they become apparent. So far, a per-operative complication has not occurred while using this system. Maserati and colleagues [15] also stated that per-operative complications such as infections and dural injuries are not characteristic of these hybrid systems.

Another advantage of the hybrid system is the decrease in morbidity and mortality compared with lengthy segmental fusion operations because the main pathological segments are supported.

A larger number of reports regarding the use of hybrid systems will be required to prove their functional and clinical efficiency. It is still unclear what level of spinal fusion, and dynamic stabilisation provides the optimal treatment for a degenerative
spine. Hybrid systems that combine fusion and non-fusion systems are expected to become more popular in the near future. Our clinical experience supports this idea.

**Result**

It is becoming apparent that adjacent segment disease is a possible late complication of spinal fusion. Studies to better understand and prevent this disease are in progress. Clearly, the developing technology of dynamic fusion surgery is an important alternative to traditional fusion surgery. Surgeons who still prefer fusion surgery should consider hybrid systems as an alternative treatment option to avoid adjacent segmental disease. There are still unanswered questions regarding this disease, but in the near future, studies will undoubtedly clarify this issue.
References


