New Techniques in the Treatment of Degenerative Disc Disease and Lower Back and Leg Pain

a report by

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One of the most controversial topics in spine literature is the treatment of degenerative disc disease (DDD). Most authors agree that non-surgical options should be the primary treatment of patients with DDD. Patients that do not respond to conservative care are amenable to surgery. Decompression, stabilisation and correction of scoliotic or kyphotic deformities are considered the three main strategies of spine surgery. Depending on the clinical and radiological manifestation of DDD, these procedures frequently need to be combined. Spinal fusion is the established gold standard for the correction of true lumbar deformities. The role of lumbar fusion for the treatment of DDD remains in debate.

Fusion surgery can generate a considerable amount of morbidity and high rates of complications. The elimination of mobility may overload adjacent segments, causing a high frequency of re-interventions. Patient satisfaction after lumbar fusion has also been reported as variable.

Consequently, the search for alternative procedures is reinforced. A ‘dynamic stabilisation’ would ideally alter the motion and load transfer of a spinal segment without fusion. Current literature describes various dynamic stabilisation systems of the lumbar spine. They either replace parts of or the whole intervertebral disc or they act posteriorly as an interspinous or transpedicular stabiliser. At present, the spectrum of non-fusion motion preservation systems pursued by industry are being researched and are increasingly being applied by the surgical community.

Two main families of disc prostheses exist: total lumbar disc replacement (TDR) devices and disc nucleus replacement devices.

Total Lumbar Disc Replacement

TDR have been performed in Europe for more than two decades. The lack of scientific clinical data and anecdotal reports of severe surgical and device-related complications prevented this new technique from spreading. Today, TDR is widely accepted as an alternative procedure to fusion in the treatment of DDD. First results, from ongoing prospective, randomised, Food and Drug Administration (FDA)-approved investigational protocols, show comparable results between TDR and fusion. In a recent publication, Siepe et al. have shown that the best results for TDR were achieved for patients with DDD with accompanying contained soft disc herniation. Previous discectomy or presence of modic changes did not negatively influence the outcome. Mono-segmental TDR performed best. Bi-segmental TDR had significantly inferior results at 12- and 24-month follow-ups and had a considerably higher complication rate.

McAfee et al. have shown that the ideal surgical placement of the total disc prosthesis correlates with improved clinical outcomes and improved flexion/extension range of motion, compared with poor surgical placement of the prosthesis. Basic conditions for a good outcome include the mastering of the difficult anterior approach to the lumbar spine and an accurate and reproducible instrumentation technique. With the emerging technology of spinal arthroplasty, a variety of new clinical problems may arise in the near future. There is, for example, a lack of knowledge about the effects of particulate and ionic debris associated with these spinal implants. The generation-of-wear debris is the primary concern of TDR degradation. McAfee et al. have shown that 8.8% of TDR patients required reoperation in a relatively short follow-up period. The incidence of vascular injuries during anterior revision surgery increased five-fold (16.7%) compared with the primary intervention. Due to the lack of real long-term outcome results and the difficulties with anterior revision surgery, the use of TDR in very young adults should be quite restrictive.

Partial Lumbar Disc Replacement

For more than 50 years, standard discectomy has been used to manage lumbar disc herniation (LDH) with favourable outcomes. Residual low back pain (LBP) and recurrent herniations are the major post-
Partial lumbar disc replacement devices remain largely investigational. Rigorous short- and long-term clinical evaluation will be critical in assessing their true efficacy.

**Posterior Motion Preserving Stabilisation Systems**

The biomechanical background of stability concepts is based on the spinal motion segment. This was first defined by Junghanns in 1968 and was later re-defined, on a precise biomechanical basis, by White and Panjabi in 1978, who introduced the term 'functional spinal unit'. The most obvious aspect of instability is excessive motion, but later non-physiologic, abnormal motion was acknowledged and named 'ys-stability'. This concept not only emphasised biomechanical considerations, but also clinical signs and symptoms such as painful motion. With respect to the pathogenesis of spinal instability in degenerative spondylosis, Kirkaldy-Willis and Farfan presented, in 1982, a convincing concept of three phases of degeneration: the dysfunctional, unstable, and the restabilisation phase of the motion segment.

Considering these concepts of spinal instability and the history of instrumentation, the rationale for spinal stabilisation can be outlined as follows: diminishing pathologic motion, prevention of deformity, reduction of deformity and compensation for iatrogenic destabilisation. A dynamic stabilising device ideally establishes pain-free segmental motion and must withstand physiologic static and dynamic loads in any plane. The concept of instability causing LBP is questioned by Mulholland and Sengupta. They propose a concept where abnormal loading patterns due to disc disorganisation occurring in DDD are responsible for LBP. Their ‘stone in the shoe’ hypothesis — that a degenerated disc is painful only at abnormal load transmission — is partially supported by modern results of fusion. Improvement in the instrumentation technique has resulted in an increase of successful fusion rate, but this has not been reflected by a corresponding increase in the rate of successful clinical outcome.

Various posterior dynamic stabilisation systems have been trialled in lumbar spinal disease with many differing biomechanical principles. Roughly, we can differ between interspinous fixation devices and transpedicular fixation devices.

**Posterior Interspinous Dynamic Stabilisation**

Recent years have seen interspinous implants gaining some popularity. Literature reviews lack...
published data about most dynamic stabilisation procedures. Senegas has published a non-randomised, prospective study comparing 80 patients (two equal groups A and B) who underwent discectomy surgery for the recurrence of herniated disc at L4/L5. Group B received a Wallis (Abbott Spine, Austin, Texas) interspinous implant in addition to the decompression procedure. The mean follow-up was three years four months. The percentage of improvement in LBP over the pre-operative visual analogue scale (VAS) score at follow-up was 52% in group A (discectomy alone) and 74% in group B (discectomy and Wallis implant). Nerve root pain was improved by 87% (group A) and 92% (group B). The Oswestry Disability Index (ODI) changed in group A from 54.7% to 22% and in group B from 58.2% to 16.4%. Overall, five patients underwent reoperations (three fusion and two decompressions) during the follow-up time. Senegas concludes that non-rigid fixation appears to be a useful technique in the management of initial forms of degenerative intervertebral lumbar disc disease. He suggests that the Wallis system is appropriate for the following indications: further to discectomy for a large herniated disc in which there is significant loss of disc material, re-discectomy for recurrent herniation, discectomy for herniation of a transitional disc with sacralisation of L5, degenerative disc adjacent to a fused segment, and isolated modic one lesion attributable to chronic LBP.

Another interspinous implant is the X STOP (St. Francis Medical Technologies). This device was designed to treat symptomatic lumbar stenosis, in particular those patients suffering from neurogenic claudication who have significant relief when sitting or flexing their lumbar spines, by placing the symptomatic segment in slight flexion and preventing extension. Zucherman et al. have published their one-year and two-year results of a prospective, randomised trial conducted at nine centres in the US. One hundred and ninety-one patients were treated with either the X STOP or with non-operative management. They observed a significantly greater improvement in clinical symptoms in the X STOP group compared with controls at all time-points. They concluded that the 59% success rate observed in this study is comparable to the 64% (good to excellent outcomes) reported in a meta-analysis of patients treated with laminectomy.

Transpedicular Posterior Dynamic Stabilisation

The main representative in this group is the Dynesys (Zimmer Spine). Dynesys was first been implanted in 1994 by Gilles Dubois. The philosophy, concept, technique and clinical results of Dynesys have been summarised in a recent publication. The main goal of Dynesys is to address dynamic instability in the early stages of degeneration as defined by Kirkaldy-Willis. As a result of the instability, the patient may experience several types of clinical symptoms. These include dynamic stenosis or stenosis with degenerativeolisthesis, as evidenced by neurogenic pain and/or LBP. Other indications for Dynesys are mono- or multi-segmental degenerative disc degeneration causing LBP, iatrogenic instability following decompression and stenosis with the early stages of gradually developing degenerative scoliosis. In multi-level DDD, Dynesys may also be combined with a fusion procedure (e.g. PLIF), depending on the severity of segmental disc disruption. Dynesys is not indicated as a primary stabilisation method in lytic (isthmic) spondylolisthesis and severe degenerative scoliotic or kyphotic deformation. Currently, 20 sites in the US are participating in an FDA investigational device-exemption, multi-centre, prospective, randomised, clinical trial evaluating the safety and effectiveness of Dynesys.

Conclusion

This article reviews several modern surgical techniques, mainly representative of the authors’ own experience. The overview of methods in the treatment of DDD can never be complete, as these new techniques evolve far too fast and are too numerous.

There is a tremendous variation in the procedures and the choice of technique throughout the world. There is insufficient clinical data comparing different treatment options to recommend preferred techniques. In order to evaluate a new technique, it is mandatory that outcome parameters like radiological and clinical data be collected prospectively.

With the advent of motion-preserving technologies for the treatment of DDD, there is great initial excitement among surgeons and patients. Improvements in techniques will only have a limited effect in combination with an inaccurate diagnosis or inappropriate patient selection.

In future, some of the financial resources should be diverted to the research of better patient selection, instead of the further evolution of pure surgical techniques.

A longer version of this article containing references can be found in the Reference Section on the website supporting this briefing (www.touchbriefings.com).
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