
# Focus On

# Recent developments in less invasive lumbar spine surgery

## Introduction

Minimally invasive surgical (MIS) techniques have been widely accepted in various orthopaedic subspecialties. Certainly, arthroscopy revolutionised the treatment of joint disorders in the early 1980s. MIS is designed to reduce the morbidity of the surgical approach, while achieving the same success rates as open procedures. Numerous studies have documented the benefits of MIS, which include shorter hospital stay, lower blood loss, reduced iatrogenic soft-tissue injury and a quicker recovery.[1-3]

A standard open posterior approach is associated with denervation of the multifidus muscle while histological studies have shown a correlation between the extent of surgical retraction and muscle necrosis.[4] Rantanen et al[5] have correlated poor clinical outcome with type II atrophy of multifidus after surgery. However, the histological features are reversible and can be improved by physiotherapy.

## Disc surgery/nerve root decompression

Although spinal MIS is perceived to be in its infancy, the earliest recorded departure from traditional laminectomy and discectomy for sciatica was in the 1950s, with the introduction of anterior retroperitoneal annular fenestration for the decompression of herniated lumbar discs.[6] The reduction in intradiscal hydrostatic pressure after fenestration results in a reduction in the disc bulge; however, the long-term efficacy of annular fenestration is not proven.

In 1972, the introduction of surgical microscopes marked the beginning of less invasive posterior spinal surgery. William[7] further refined the technique so that lumbar microdiscectomy remains the most common surgical intervention for lumbar disc herniation. Foley and Smith[8] have described an alternative technique, microendoscopic discectomy. A randomised controlled trial (RCT) comparing microendoscopic discectomy with open discectomy found a significant reduction in hospital stay with microsurgical techniques, although there was no difference in blood loss or the time taken to return to work.[9]

An interspinous spacer offers an alternative to lumbar decompression surgery for the treatment of neurogenic claudication secondary to spinal stenosis. Cadaver studies have demonstrated that spacers can increase the canal diameter by 18% and foraminal area by 25%.[10] Radiological studies have also shown that sagittal alignment changes by less than one degree for single-level implants and by slightly more than one degree for two-level implants.[11] Zucherman et al reported the results of a randomised controlled trial (RCT) comparing the results of interspinous spacers and lumbar epidural at two years. Only 6% of those with spacers required further intervention, which was similar to other reports in the literature.[12] In another RCT, Anderson, Tribus and Kitchel reported a clinically significant improvement at two years in 63.4% of patients after implantation of an interspinous spacer compared with 13% who had received an epidural.[13] Both of these RCTs were sponsored by industry. At present there are no trials comparing the insertion of an interspinous spacer with lumbar decompressive surgery.

## Spinal fusion

Magerl first reported the use of percutaneous pedicle screws for spinal fusion in 1982.[14] Matthew et al suggested placing the rods in the subcutaneous tissues in order to reduce the risk of infection,[15] although the relatively superficial implants make this technique poorly tolerated by patients. Foley et al[16] subsequently revised the instrumentation in order to allow subfascial placement of the rods. Advances in the design of percutaneous pedicle screws, combined with the tubular retractor system developed by Foley and Smith,[8] led to the development of minimally invasive transforaminal lumbar interbody fusion (TLIF), posterior lumbar interbody fusion (PLIF) and posterolateral fusion. Peng et al[3] reported that after minimally invasive TLIF patients had a statistically significant reduction in post-operative pain and blood loss compared with those who had undergone open TLIF. However, there was a threefold increase in fluoroscopy time during surgery while the outcome at two years was similar.

The standard approaches for anterior lumbar interbody fusion (ALIF) are the anterior retroperitoneal and transperitoneal approaches. Bergey et al[17] reported the preliminary results of endoscopic lateral transpsoas retroperitoneal lumbar fusion in 21 patients; fusion was achieved in all cases, with no subsidence of the cage. Zdeblick and David[18] compared the laparoscopic transperitoneal approach with mini-open access for the lumbar spine and found that the laparoscopic approach had a 20% complication rate. This compared with a 4% complication rate for a mini-open approach. Additionally, 10% of laparoscopic cases had to be converted to open surgery because of bleeding and peritoneal tears. In a separate study, Rodriguez et al[19] found no difference in post-operative analgesic requirements or the length of hospital stay between laparoscopic and open procedures.

## Vertebral cement augmentation

Percutaneous vertebroplasty (PV) is a minimally invasive procedure now commonly performed for the treatment of pain associated with osteoporotic vertebral compression fractures and osteolytic metastases. It was first reported in 1984 by Galibert et al[20] for the treatment of haemangiomata of the cervical spine. This resulted in complete pain relief and a subsequent series of six patients was published in 1987. Lapras et al[21] and Bascoulergue et al[22] subsequently modified the technique by injecting polymethylmethacrylate (PMMA) into osteoporotic fractures of the vertebral body and osteolytic spinal metastases. In the early 1990s, Wilson et al[23] introduced an inflatable balloon which can be used to restore vertebral body height and minimise kyphotic deformity. Based on 329 cases published between 1985 and 2004, pain reduction varied between 70% and 90%. A meta-analysis based on the literature from 1983 to 2004 by Taylor, Taylor and Fritzell[24] concluded there was reasonable evidence to support both vertebroplasty and kyphoplasty in the management of symptomatic, osteoporotic vertebral compression fractures. There was also a statistically significant improvement in vertebral height and kyphotic angle in comparative studies. A meta-analysis of complications reported significantly more cement extrusion and procedure-related complications in vertebroplasty compared with kyphoplasty.[25] A recent multi-centre RCT by Buchbinder et al[26] concluded there were no benefits compared with sham procedures. Unfortunately, there was a potential bias in the study as only 78 cases were recruited into the trial, from a cohort of 468. In addition, there is concern about 'insufficient vertebroplasty' because a mean of only 2.8 ml of cement had been injected into the vertebral bodies.

## Spinal trauma

The application of MIS techniques to spinal trauma can be used to address decompression, realignment and stabilisation of the spine. It is an attractive option to minimise further soft-tissue trauma and limit the inflammatory response, especially in patients who sustain multiple injuries. In patients with flexion distraction injury of the spine, the posterior tension band can be restored with a percutaneous short-segment pedicle screw; percutaneous screws can also used to augment anterior column reconstruction. Compared with standard open techniques, MIS demonstrates reduced blood loss, less peri-operative pain, and earlier mobilisation.[27]

## Spinal deformity/thoracoscopic surgery

Video-assisted thoracoscopic (VAT) spinal surgery became popular in the 1990s, particularly in scoliosis.[28-30] Newton et al[31] published a series of 38 cases in which thoracoscopic instrumentation was used in idiopathic adolescent scoliosis, concluding that the degree of correction achieved compares well with cases treated by thoracotomy. VAT staple hemi-epiphysiodesis has also shown promising results in the correction of selected scoliotic deformity cases. Betz et al[32] reported that 79% of patients with a thoracic curve of less than 35°, and 87% of all lumbar curves, had an improvement of more than 10°. The indication for VAT also extended to thoracic discectomy and fusion, corpectomy for trauma and tumour-related spinal pathologies.

## Intradiscal procedures

MIS procedures for the treatment of lumbar intradiscal disease are rapidly expanding and continue to challenge conventional surgical management. Saal and Saal[33] introduced an alternative method for the treatment of discogenic back pain, using controlled thermal energy delivered through an intradiscal catheter. It has been suggested that intradiscal electrothermal therapy (IDET) may coagulate annular nociceptors and lead to contraction of the collagen. This would address both the nociceptive and mechanical components of discogenic pain, although the long-term effects of collagen shortening and restructuring are not known. Two subsequent RCTs produced conflicting results. Freeman et al[34] concluded that IDET did not produce any benefit compared with a sham procedure. Meanwhile, Pauza et al[35] reported a statistically significant improvement compared with a placebo group. Percutaneous intradiscal radiofrequency (RF) is a variant of IDET that involves the application of an alternating radiofrequency current to the disc annulus. A recent systematic review of nonsurgical intervention therapies for low back pain has concluded there is insufficient evidence to evaluate reliably the efficacy of IDET, while there is good evidence that radiofrequency thermocoagulation is not clinically effective.[36]

Advances in medical technology have enabled the use of neodymium-doped yttrium, aluminium and garnet (Nd:YAG) lasers and cryoablation to reduce intradiscal pressure for the treatment of sciatica secondary to discogenic back pain. These have shown promising results in case series and observational studies[37,38] but unfortunately there is a lack of firm evidence of their efficacy.

## Conclusion

The technology of MIS procedures in spinal surgery will continue to evolve in parallel with advances in robotic technology and three-dimensional image-guidance systems. However, a long learning curve, combined with the cost, may limit acceptance of MIS in mainstream spinal practices. To justify this learning curve, quality studies that can demonstrate clinical superiority in long-term outcomes are essential.

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