Degenerative lumbosacral stenosis (DLSS) is a syndrome of disc, articular fascet, vertebral and soft-tissue associated dynamic or static compression of the cauda equina and L7 nerve roots. DLSS is the most common cause of compression of the cauda equina and L7 nerve roots in dogs, where disc material, inflammatory tissue or vertebral malformation cause dynamic or static impingement. In clinical reports to date, there is paucity of documentation and measurement of neuroforaminal abaxial impingement, especially with regard to the clinical contribution of exit-zone impingement of the L7 nerve root. Surgical treatment has historically targeted specific components of the disease by means of dorsal laminectomy, annulectomy, nuclear extirpation, fascpectectomy, foraminotomy, fascet stabilisation or application of dorsal stabilising implants. Selection criteria for surgical intervention and long-term outcome data have been poorly defined. This is especially relevant where the exit zone of the neuroforamen may be encroached by soft tissue or osseous deformity and where dynamic instability is present. Medium-term recurrence of clinical signs has variably been reported as 18-54.5%. Magnetic Resonance Imaging (MRI) has been validated as a useful interrogation tool and may be superior to Computed Tomography (CT) scan in terms of elucidation of the soft-tissue component of neural encroachment, whilst CT defines well the osseous anatomic boundaries.

Cervical Spondylomyelopathy (CSM or Wobbler syndrome) is a progressive disorder of cervical spinal cord compression, caused by one or multiple contributing factors: vertebral anomalies, degenerative changes of the intervertebral discs or spinal ligaments, and articular facet changes or malformations. CSM primarily affects the caudal cervical vertebrae in large to giant breed dogs. Clinical signs range from neck pain to thoracic limb ataxia to non-ambulatory paresis. Disc associated wobbler syndrome (DAWS) describes protrusion of one or more degenerative cervical discs into the spinal canal causing compression of the spinal cord. Conservative management generally implies strict confined rest, medical management and possibly the addition of a neck brace, the merits of which have not been qualified. A decision for treatment of disorders of the cervical spine is generally based on the neurological status of the patient, the degree of spinal cord compression, and whether the lesion is dynamic (responsive to traction, flexion, or extension) or static (not changed by vertebral column position). MRI is considered to be the most sensitive technique for providing diagnostic information on spinal cord compression, both in humans and dogs, whilst CT scan provides pertinent data concerning osseous boundaries of the cervical spinal canal. These modalities have largely replaced traditional myelography at most referral centers.

There are many surgical options for cervical compressive lesions, most of which have reportedly similar results, and include dorsal laminectomy, lateral laminectomy and facetectomy, ventral slot, partial slot with distraction stabilization, and distraction stabilization with a spacer device of some kind. Decompression alone cannot adequately address vertebral instability and such patients may have improved post-operative outcomes with distraction-stabilization. Humans are reported to have less short-term neck pain and loss of surgical decompression when some form of stabilization is utilized. Vertebral distraction-fusion techniques provide rigid internal fixation and are especially indicated in the presence of dynamic spinal cord compression. Numerous methods for achieving distraction-stabilization of the cervical spine have been reported, including screws and plates (locking or non-locking), cage spacers, interbody polymethylmethacrylate, various pin/screw/polymethylmethacrylate constructs, bone graft or blocks, and arthroplasty with prosthetic discs. In the cervical spine, stabilization may be the most salient surgical prerogative, though there are occasions where replacement of a disc with a mobile replacement device may be advantageous. 

Complications reported with surgery of the cervical spine include implant failure, iatrogenic invasion of the spinal canal, intervertebral foramina, or vertebral artery, and collapse of the operated or adjacent disc spaces. Implant failure or collapse of distracted areas can lead to clinical deterioration due to continued instability. The variable success rates reported for maintaining distraction of the disc space and achieving bony union indicate the desirability of a more stable construct.
Thoraco-lumbar and lumbar intervertebral disc protrusion is a common cause of upper motor neurone impairment of the pelvic limbs in large breed dogs with certain breed predilections geographically identified. A syndrome of pelvic limb paresis progressing to paralysis has been well described and the degree of myelomalacia is largely determined by lesion size, location, chronicity and whether it is dynamic or static in nature. Obvious differentials of degenerative myelopathy, intervertebral disc extrusion, discospondylitis and neoplasia are generally excluded by appropriate imaging. In this regard, MRI has largely replaced conventional myelography and is more specific and sensitive regarding type and magnitude of disease. Historically, decompression techniques have constituted laminectomy or corpectomy. More recently, fusion of the affected segments using locking plates has been shown to be effective. Challenges remain for both decompressive and stabilization techniques in the sense that with decompression, often the spinal cord segment has been chronically compressed and is significantly compromised. Therefore any surgical intervention which involves encroachment of the compromised spinal cord can cause iatrogenic trauma, which may sometimes be irreversible. Additionally, often the disease affects multiple discs and extensive laminectomy and facetectomy can destabilize the spinal elements and in itself can cause iatrogenic spinal trauma. Though stabilization may be the most salient factor in promoting clinical improvement, there may be patients where ancillary decompression may be advantageous, particularly where large static protrusions are evident, which can continue to produce neural conduction impairment, even after stabilization. Furthermore there may be cases of thoracolumbar or lumbosacral discospondylitis where surgical debridement of the affected sites may compromise stability and ancillary stabilization may facilitate expeditious recovery.

The concept of intervertebral distraction using an allogenic or synthetic spacer combined with intervertebral stabilization has been applied frequently and successfully in the management of cervical spondylopathy. To the authors’ knowledge, such a technique has not yet been applied to the lumbosacral or thoracolumbar spine in dogs. The Fitz Intervertebral Traction Screw (FITS, patent pending) is a titanium, tapered, threaded, headless distraction implant which was designed to facilitate immediate and durable distraction between paired intervertebral bodies. Stabilization of the components of the spinal column using vertebral body pins and bone cement is a currently accepted technique for the cervical and thoracolumbar spinal regions and the author elected to combine techniques using the FITS device and adjunctive fixation elements for cervical, thoracolumbar and lumbosacral spinal segments.

In a pilot proof-of-principle study, eight pelves of mix-breed dogs weighing 25-34kg were harvested en bloc from L4-L5 caudally, preserving the epaxial musculature. MRI was performed before and after the surgical procedure, 2mm-2.5mm slices of T1 and T2 sequences, in sagittal, transverse, dorsal and parasagittal 45° oblique planes, approximating orientation perpendicular to the true course of the L7 nerve root in the neuroforamen. Neuroforaminal area (cm²) was measured on parasagittal oblique images at the entry, middle and exit zones of the nerve root. On dorsal plane images, the distance between the end plates of L7 and S1 were measured (mm) at four equidistant transverse points from left to right to encompass axial and abaxial extents. A standard dorsal laminectomy without facetectomy was followed by intervertebral disc annulectomy and nuclear extirpation. Due to image distortion caused by metallic implants, a solid plastic polymer FITS was manufactured in dimensions exactly mimicking the surgical-grade implant and this was inserted manually into the IVD space. Dorsal stabilisation was provided using 3mm wooden dowels to simulate the metallic threaded pins used in vivo, and placed across the articular facets (2 pins), into the vertebral body of L7 bilaterally (2 pins), and across the sacro-iliac joints bilaterally (4 pins). These dowels were held in position using a bolus of modelling clay, which had been shown not to distort image clarity. Statistical comparisons between pre- and post-operative measurements were performed using a paired non-parametric test (Wilcoxon signed rank, significance level set at P < 0.05) for entrance, middle and exit zones of the neuroforaminae, and for end-plate distances. All statistics were performed 2-tailed with respect to the study hypothesis, using software (SPSS Inc., Chicago, IL).

Significant distraction of L7-S1 end-plates and neuroforaminal enlargement were obtained in all 8 pelves. Using a non-parametric Wilcoxon signed rank test, all areas measured post-operatively were statistically significantly increased by comparison with pre-operative values, at entrance, middle and exit
zones of the neuroforamenae (right and left sided), on T1 and T2 images (P= 0.01). On the left side, on T1 images, the areas at entrance, middle and exit zones increased 64.5%, 77.5% and 97.9%, respectively; on the right side, on T1 images, the increase was 70%, 91% and 82.9%, respectively. Post-operative distances between L7-S1 end-plates were also statistically significantly increased by comparison with pre-operative measurements, at every single point of measurement (left and right, axial and abaxial), with P= 0.01.

Application of the FITS implant in this cadaveric model resulted in distraction of the endplates of L7-S1 and enlargement of all zones of the L7 neural exit pathways. Though application of dorsal pins and cement served to simulate the clinical scenario as closely as possible, distraction was attributable to the FITS device alone. The application of parasagittal oblique imaging in the manner described may assist enhanced assessment of encroachment of the actual course followed by the nerve root, having recent precedent in human patients. This may have greater clinical relevance than designation of entry, middle and exit zones as described in current veterinary literature, which more specifically describe the osseous boundaries of the lumbosacral junction in the region of the L7 neuroforaminae rather than the nerve pathways per se, but further studies are indicated to validate this novel imaging plane in the canine lumbosacral spine. Of particular relevance is the exit zone, which is frequently subjected to dynamic and static impingement in clinical cases. Application of the technique described may be pertinent for alleviation of such encroachment by distraction collinear with the spinal axis and stabilization at anatomic rather than accentuated LS angulation. The study provided proof-of-principle for clinical application of the technique in the lumbosacral spine. Application to the cervical and the thoraco-lumbar spine is the subject of ongoing in vitro and in vivo validation.

References