Vertebral fractures and luxation are a common cause of neurologic injury in cats, most frequently because of road traffic accidents, animal attack and falling from a height. They usually occur at the junction between stable and more mobile areas of the spine. The terminal thoracic region is most affected followed by sacrococcygeal, lumbar and cervical. There is some debate whether conservative or surgical management is most appropriate in individual cases. The objective of surgery in such cases is to decompress the spinal cord, reduce the fracture/luxation and provide rigid stabilization of the vertebral column. In human patients, pseudo-arthritis formation after unsuccessful vertebral fusion has been associated with chronic neurogenic pain. Therefore, implants providing rigid stability are considered advantageous. Vertebral body plating, vertebral stapling, cross pins, screws or pins and cement and external skeletal fixation have all been described.

Degenerative lumbosacral stenosis (DLSS) is a commonly recognized neurologic condition in dogs, but poorly documented in cats. It is believed that the incidence of DLSS could be similar than the described in dogs but may frequently go unnoticed or undiagnosed. Components of this disease syndrome include intervertebral disc degeneration (IVDD), facet joint osteophytosis/malformation, spondylolisthesis and discospondylitis. Clinical signs may include lumbosacral pain, hyperesthesia, pelvic limb paresis, unilateral or bilateral pelvic limb lameness and urinary and/or fecal incontinence. Though anomaly (especially mismatch in vertebral alignment) may be evident radiographically, MRI and CT scans are superior modalities in terms of sensitivity and specificity. There is a paucity of surgical reports in the veterinary literature and intervention has primarily been documented by dorsal laminectomy and annulectomy, with only sporadic case reports of stabilization. Recurrence of clinical signs following decompression alone has been described as 18% in one study (Danielsson) and 16.7-54.5% in another (Linn). High recurrence rates may be due at least in part to underlying dynamic instability with associated ongoing impingement of the cauda equina and L7 nerve roots. Appropriate stabilization would potentially prevent such impingement and may also prevent exuberant formation of fibrous tissue that could cause nerve root compression.

Six cats with vertebral fracture-luxation and six with lumbosacral pain were identified and treated by the author between 2007 and 2010. Signalment data were collected regarding breed, sex, age, weight, history (type of trauma, duration and progression of the clinical signs), neurological assessment (preoperatively, postoperatively, at discharge and at six weeks post-operative recheck). Diagnosis was based on neurological examination, digital radiographs and magnetic resonance imaging. The preoperative neurological status for each cat was graded using a 5-point scale adapted from Matthiesen. All cats were allowed home to cage-rest confinement when voluntary urination was evident and motor function was apparent for all four limbs. Radiographs were taken 6 weeks after surgery for all cats. Passive range of motion physiotherapy and assisted standing and proprioceptive feedback exercises were performed for all trauma patients for four to six weeks post-operatively but not for any cats treated for lumbosacral pain.

Poor outcome was defined as persist difficulty in voiding urine and/or no improvement in gait after treatment. Functional recovery was defined as the cat becoming an acceptable household pet in terms of bladder control and the ability to undertake unassisted and pain-free ambulation. Excellent recovery was ascribed to cats manifesting normal urination and no gait or proprioception abnormalities.
Five cats had vertebral fractures caused by road traffic accident and one due to dog attack. Breeds presented were Tonkinese (n=1), Burmese (n=1), Siamese (n=1) and Domestic short hair (n=3). Mean age was 16.6±5.64 months. Mean body weight was 3.4 kg (range: 3.04-3.88 kg). Mean neurologic score at presentation was 3.6±1.1. All cats were affected by fracture at the thoracolumbar junction (between T11 and L4). One was affected by fracture of the caudal L2 end plate with minimal dorsal displacement and a caudo-ventral L3 vertebral body fracture with 50% dorsal displacement. One was affected by fracture through the cranial to mid-vertebral bodies of L3 and L4. The fracture in the vertebral body of L4 was displaced and compression of the spinal cord was evident centrally and to the left. The remaining 3 cats were affected by fracture at a single site, involving the vertebral physis. Two cats presented with loss of deep pain sensation.

A limited hemilaminectomy and ventral facetectomy was performed in all cats affected by vertebral fractures, which facilitated decompression of the spinal cord and exposed the cancellous bone at the junction of the vertebral laminar arch and body. Miniature INTERFACE pins™ (Imex™, Veterinary Inc.) pins were placed obliquely into the vertebral bodies at this cancellous entry zone. The inter-cortical bone provided instant purchase for the thread of the pin without impaction with cortical bone swarf. A minimum of 2 pins were placed per vertebral body. Preoperative measurements in conjunction with direct visibility of the thread entry allowed accurate insertion depth judgment to exit approximately 2 mm from the ventral aspect of the vertebral body. Traction was applied in a linear fashion between the most cranial and most caudal pin using either a clamp-rod extender or by applying the tips of Gelpi retractors under crooked tips of these pins. A wet-stable collagen hemostat foam (Lyostypt, Braun®) was placed over the spinal cord to offer protection from the termogenic cement curing. All except the most far-apart pins used for traction, were cut to appropriate length, leaving an etched portion of each pin exposed for cement purchase. Gentamicin-impregnated polymethylmethacrylate (Simplex®, Howmedica International S. de R.L) in semi-liquid phase was molded around the pins, using wooden spatulae as guidance and then the remaining two pins were cut level with the surface of the cement bolus. Application of ventrally directed pressure to the pins in adjacent segments facilitated correction of dorsoventral spinal deviation as the cement set. Closure was routine.

Mean hospitalization stay for vertebral fracture-luxation cats was 29.6 days (range: 5-63 days). Three of six cats had deep pain present immediately at recovery, one regained deep pain perception within the first week post-operatively and one at 18 days postoperatively. The remaining cat never recovered deep pain sensation. The mean time for recovery of voluntary urinary function was 19.4 days (range 1-60 days). One patient suffered urinary infection postoperatively which responded to sensitivity-directed systemic antibacterial therapy. Pelvic limb motor function recovered by 1 to 23 days postoperatively (mean 10.6 days). Radiographic and neurologic evaluation was performed for all cats at a minimum of 6 weeks postoperatively. Radiography revealed maintenance of position and integrity of all implant constructs. Final clinical examination was performed at a mean of 60.6 days (range 42-125 days). Four cats scoring less than grade IV neurological dysfunction at initial presentation, recovered completely, one cat which was grade V at initial presentation was affected by occasional urinary “leakage” at night, but pain-free normalized gait was restored and one cat which was grade V at initial presentation was euthanized at the owner’s request 54 days postoperatively.

Six cats were identified with lumbosacral pain. One was affected by acute bilateral pelvic limb lameness and a flaccid tail, four by persistent unilateral pelvic limb lameness and one by persistent bilateral pelvic limb lameness. Breeds included Maine Coon (n=1), Bengal (n=1), Siamese (n=1), DLH (n=1), DSH (n=2). Patient age was 113.13±44.07 (mean±SD) months and body weight ranged from 3.3 to 7.3 Kg (mean=5.61). All cats adopted an outdoor
lifestyle. Mean duration of clinical signs was 136±124 days (range from 2 to 365 days). The mean value for neurological score at presentation was 1.66±0.47. All cats maintained conscious voluntary urination. For all patients, pain was evident upon application of deep digital pressure to the dorsum of the lumbosacral spine and all owners reported reluctance to jump into objects such as furniture and abnormal spontaneous vocalization. MRI scan of the LS junction in all cats revealed inter-vertebral disc degeneration with variable degrees of dorsal herniation of the annulus fibrosus which was exacerbated by hyperextension of the LS joint. Transverse imaging and oblique parasagittal imaging revealed encroachment of the L7 nerve roots by inter-vertebral disc protrusion and new bone formation. Spondylosis and sclerosis of the end plates of L7 and S1 vertebral bodies was radiographically apparent for two cats and spondylolisthesis with dorsal laminar mismatch was evident for two cats. One cat was additionally affected by sacralization and marked distortion of the central canal and neuroforaminae of the seventh lumbar vertebra.

For DLSS patients, a dorsal laminectomy at the lumbosacral junction was performed followed by dorsal annulectomy and nuclear extirpation. With the spine positioned neutrally, one miniature INTERFACE pin™ of appropriate diameter was placed into each lumbosacral facet. Two Miniature INTERFACE pins™ were placed in pre-drilled holes at the junction between the lamina and the pedicle in L7 vertebral body bilaterally directed cranioventrally from abaxial to axial, bisecting the angle created by the ilial wings and the L7 vertebral arch and taking care to place the entry point at the junction of the transverse process and the vertebral body. Two Miniature INTERFACE pins™ were also placed in pre-drilled holes in the sacral body caudoventrally from axial to abaxial with intent of maximizing purchase in the alar wings. The laminectomy site was covered with a wet-stable collagen hemostat foam (Lyostypt, Braun®). All pins were cut to appropriate length and imbibed in a bolus of polymethylmethacrylate cement.

Mean hospitalization stay for DLSS patients was 2.83±0.68 days. Surgery did not result in deterioration of clinical signs for any case. Lameness resolved in 5 of 6 cats within 3 days and for one cat by 2 weeks postoperatively. Radiography at 6 weeks revealed maintenance of position and integrity of all implant constructs. Final clinical examination was performed at a mean of 79.8 days (range 42 to 159 days), with all owners reporting appropriate pain-free resumption of normal activity including running and jumping. Mild intermittent lameness 2/10 was reported for one cat at seven months postoperatively with suboptimal ability to jump. Clinical examination and radiography did not reveal problems at this time and subsequently this patient returned to normal activity according to the owner.

There may be a role for conservative management of spinal fracture-luxations with or without spinal splint support in selected cats. However, pain due to instability can be a cause of significant pain and splint supports are generally difficult to maintain for cats. Definitive indications for surgical intervention include imaging evidence of spinal cord compression, dynamic instability and disruption of the spinal canal and/or nerve roots. In this regard MRI and CT scans are superior to radiography and myelography may be contraindicated. Many implant options have been described for surgical stabilization of the disrupted vertebral column in dogs and cats. Application of pins and polymethylmethacrylate for successful treatment of spinal instability in the thoracolumbar region has been reported in dogs and cats (Bruce). Complications reported have included implant loosening, implant breakage and pin migration. The disadvantages of using bone cement include potential increased infection risk, possibility of pin migration, potential compression of adjacent structures, bulky implants which may be difficult to cover and challenges if revision surgery were to be required. Advantages intrinsic to the implant construct include the ability to place bone anchors in a multi-planar fashion to maximize bone purchase and the ability to use these anchors to manipulate (usually distract) bone segments (adjacent vertebrae).
DLSS is commonly diagnosed in dogs and humans, but uncommonly so in cats, most likely because lifestyle characteristics of cats may hide symptoms from even attentive owners, who may also ascribe changes such as reluctance to jump, increased aggression, spontaneous vocalization or perceived pain during grooming or picking the cat up in a certain way, attributable to inevitable ageing change or orthopaedic disease such as osteoarthritis. Owners may also be unaware that the problem could actually exist and both owners and clinicians may not be familiar with surgical intervention as an option at all. DLSS may be predisposed by congenital or developmental vertebral abnormalities such as Hansen type-II disc protrusion, hypertrophied soft tissue (ligamentous and synovial structures), osteophytosis of the lumbosacral joint, lumbosacral spondylosis and instability, as in the cases presented here. Vertebral malformations such as transitional vertebrae may also predispose DLSS by altering the biomechanical environment. There have been multiple accounts of lumbosacral intervertebral stabilization in dogs using various implants but there is a paucity of such reports in cats, and even where diagnosed, feline LS pain is often treated using medical management or lifestyle modification.

Imex INTERFACE pins™ lend themselves well to these applications in feline patients. Sizes suit even the smallest osseous targets, including the articular facets, they have excellent bone holding strength and machine-etching of the shaft facilitates cement bonding, especially where pins are placed at diverging angles. The positive thread of the Miniature INTERFACE pins™ covers one and a half centimeters, thus facilitating judgment of penetration depth by tactile feedback, visual perception and guidance using preoperative radiographic measurements. This may help to minimize surgical time and may reduce the risk of over-zealous trans-cortex penetration, avoiding potentially catastrophic consequences such as iatrogenic violation of the pleura or major vessels. The techniques described also minimize the size of surgical approach required by comparison with plate-screw techniques for example. Contrary to some previous opinion, it is the view of the author that limited hemilaminectomy aids spinal canal decompression, affords valuable direct visibility of the cord to assess integrity or otherwise, facilitates access for reduction of fracture-luxation, and ensures accurate trajectory of pin placement in appropriate bone stock without pre-drilling. The use of temporary linear distraction fixators or Gelpi retractors is a novel adjunct to technique and further facilitates reduction. In the case of application of pins and cement to the lumbosacral junction, the primary advantage of Imex INTERFACE pins™ is the ability to place implants in a multidirectional fashion and provide resilient anchors for stabilization following laminectomy, hence removing the drivers of pain in this region which include nerve root compression and persistent instability. We did not experience implant loosening in this case series for either application and long-term follow-up is ongoing at the time of writing.

References:
8 Matthiesen DT: Thoracolumbar spinal fractures/luxations: Surgical management. Comp Cont Ed Sm Anim Practice 5:867-878, 1983