Management of degenerative lumbosacral disease in cats by dorsal laminectomy and lumbosacral stabilization

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Keywords
Cauda equina syndrome, lumbosacral stabilization, miniature interface pins, feline

Summary
In this case series we describe the diagnosis and surgical treatment of five cats affected by clinical cauda equina syndrome as a result of degenerative lumbosacral stenosis. Radiographic and magnetic resonance imaging findings confirmed the suspected diagnosis of disc-associated lumbosacral disease. Cauda equina decompression was achieved by dorsal laminectomy followed by dorsal annulectomy and nuclear extirpation. Dorsal stabilization was achieved using miniature positive-profile pins inserted into the vertebral body of L7 and the wings of S1 with the free ends of the pins being embedded in a bolus of gentamicin-impregnated polymethylmethacrylate. Reassessment two years postoperatively using a previously validated feline specific owner questionnaire indicated satisfactory outcome with complete return to normal activity and resolution of signs of pain in all cases.

Introduction
Clinically significant intervertebral disc disease has been recognised infrequently in cats, with estimates of incidence varying between 0.02% and 0.12% (1). Historically there may have been a tendency to underestimate the incidence of chronic orthopaedic and neurological diseases in cats. Recent improvements in our appreciation of the typical feline response to chronic pain have resulted in an increased recognition of several important conditions, including osteoarthritis and spinal disorders (2, 3). Common clinical signs in cats affected by lumbosacral intervertebral disc disease are spinal hyperaesthesia, reluctance to jump, reduced activity, low tail carriage, pelvic limb ataxia, and difficulty when posturing to defecate (1, 4). Confirmation of the diagnosis of lumbosacral intervertebral disc disease in cats and dogs displaying these typical signs has been challenging because definitive diagnosis requires magnetic resonance imaging (MRI), computed tomography (CT)-myelography, surgical exploration based on typical radiographic changes, or post-mortem histopathological examination (4-8). A greater number of cats have been included in radiographic and histopathological studies than in clinical studies, which have been limited to case reports and small case series (8-14).

Three case reports documented the clinical signs and surgical outcome in cats with cauda equina syndrome as a result of degenerative lumbosacral stenosis (4, 16, 17). In two reports, surgical treatment was by dorsal laminectomy and fenestration (16, 17). In the first case series of six cats, the postoperative follow-up ranged from three to 35 months and, based on an owner questionnaire, outcome was judged as excellent in four cats and fair in two (16). However, the owner questionnaire was examining only basic levels of function of the cats over a short-term period and in two cases (33.3%) the clinical signs persisted. The second case report documented a single cat treated by dorsal laminectomy and fenestration. The outcome was considered excellent, with all previous neurological deficits having resolved by four months after surgery (17). Nevertheless, no long-term clinical data or comments were available regarding the activity levels and behaviour of the treated cat. In a third case report on a single cat, surgical management involved a combination of lumbosacral laminectomy and dorsal stabilisation using screws and polymethylmethacrylate (PMMA) (4). The outcome was judged as excellent due to normal orthopaedic and neurological examinations performed 18 months postoperatively.

The purpose of this case series is to report the technique and surgical outcome of five cats that were suffering from cauda equina syndrome due to degenerative lumbosacral stenosis and were treated by dorsal laminectomy combined with spinal stabilization using pins and PMMA.
Materials and methods

The medical records of cats referred with a history of spinal hyperaesthesia or neurological signs attributable to cauda equina syndrome between January 2007 and December 2010 were reviewed. Inclusion criteria included clinical signs compatible with degenerative lumbosacral stenosis, confirmation of lumbosacral stenosis based on MRI and intra-operative findings, and subsequent surgical decompression and stabilisation using positive profile pins and PMMA. For each cat, the following data were recorded: age, sex, breed, body weight, presenting signs, duration of clinical signs prior to presentation, radiographic and MRI findings, surgical findings, postoperative complications and outcome.

Radiographic analysis

Orthogonal radiographs of the lumbosacral articulation and pelvis were obtained preoperatively, immediately postoperatively, and at six weeks after surgery. All radiographic images were acquired with digital radiography\textsuperscript{a} and picture archiving and communications software\textsuperscript{b} while the animal was under routine general anaesthesia. Radiographs were assessed for signs of intervertebral disc space collapse, vertebral end-plate deformation or sclerosis, ventral and abaxial new bone formation adjacent to the lumbosacral joint, and presence of a step between the seventh lumbar (L) and first sacral (S) vertebral bodies. Implant positioning and lumbosacral alignment were assessed on the immediate postoperative radiographs.

Magnetic resonance imaging

Magnetic resonance imaging was performed using a first generation 1.5T MRI scanner\textsuperscript{c}. The cats were positioned in dorsal recumbency with the pelvic limbs extended caudally. Turbo spin echo sequences were used for all MRI sequences. Sequences included a minimum of:

- Sagittal T2-weighted images acquired along the long axis of the lumbar spine (repetition time [TR] 3500-5000 ms; echo time [TE] 90-100 ms; field of view [FOV] 260 mm\textsuperscript{2}; slice thickness [ST] 1.5 mm; inter-slice gap [ISG] 0.2 mm)
- Transverse T2-weighted images acquired parallel to the intervertebral disc space (TR 3500-5000 ms; TE 90-100 ms; FOV 130 mm\textsuperscript{2}; ST 3 mm; ISG 0.3 mm; and 4-5 averages).
- Transverse T1-weighted (TR 654 ms; TE 13 ms; ST 1.5 mm; ISG 0.2 mm; FOV 130 mm\textsuperscript{2}; and 4 averages).

The MRI criterion for defining a foraminal disc herniation was focal extension of the disc margin beyond the vertebral margin of the foramen, with resulting nerve root or foraminal fat displacement (17). Foraminal stenosis was defined as distortion or paucity of foraminal fat and diminution of the overall size of the intervertebral foramina (18, 19).

Surgical procedure

The cats were positioned in ventral recumbency with the pelvic limbs flexed cranially and tucked under the abdomen in order to moderately hyperflex and accentuate the L7-S1 interarcuate space. After routine aseptic preparation, a standard dorsal midline approach to the L7 and the sacrum was performed as described previously (20). The dorsal spinous processes of L7 and S1 were removed using rongeurs and the ligamentum flavum was excised by sharp dissection. A dorsal laminectomy, preserving

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\textsuperscript{a} Eklin Medical Systems, Santa Clara, California, USA

\textsuperscript{b} Merge, Milwaukee, Wisconsin, USA

\textsuperscript{c} Siemens Symphony Magneton\textsuperscript{TM}: Siemens, Erlang, Germany
the articular facet joints, was performed using a high-speed pneumatic burr followed by dorsal annulectomy and nuclear extirpation. Miniature profile pins were used throughout. These pins have trocar points on both the smooth and threaded ends, and the central area of the pin shaft is factory-roughened to enhance the interface between the acrylic frame and pin. The first two pins of 1.6 mm to 2.0 mm diameter were drilled across each L7-S1 facet joint (in a cranio-axial to caudo-abaxial direction) (Figure 1B). Two pins were inserted at the base of the cranial articular process of L7 with an angle of 0-20° (towards sagittal midline) (Figure 1A). The pins were driven until the ventral cortical bone of L7 was just penetrated. The subsequent pair of pins were drilled from immediately caudal to the cranial articular surface of S1 with an angle of 0°-45° relative to the sagittal plane and an angle of 0°-30° relative to the transverse plane into the sacral body, with the intent of maximizing purchase in the sacral alae wings (Figure 1C). The final pair of pins were inserted into the lateral sacral crest, starting 2-3 millimetre caudal to the previously inserted sacral pins, taking great care not to damage the S1 nerve roots (Figure 1D). Where possible, these final pins were started immediately cranial to the S1 neuroforamen; if this was not possible (because of concerns for iatrogenic trauma to the S1 nerve roots), these pins were placed between the S1 and S2 neuro-foraminae and directed craniolaterally in order to maximise purchase in the lateral aspect of the sacral crest. During pin insertion, the remaining proportion of threads on the pins were used as a guide to intra-operative pin depth (appropriate depth was roughly estimated from preoperative radiographs). All the pins were inserted following the indications for optimum implantation corridors in the L7 and S1 vertebrae (21). The surgical field was irrigated with sterile solution and dried using gauze sponges in preparation for the application of the PMMA. The laminectomy site was covered with a moisture-stable collagen hemostatic foam sponge. All pins were cut 5 mm to 10 mm above the level of the dorsal laminae, leaving a portion of roughened shaft exposed to improve the cement-pin interface. A 20 ml aliquot of gentamicin-impregnated PMMA in semi-liquid phase (stirring time of approximately 2.5 minutes) was applied dorsally to enshroud all pins. Modelling of the cement bolus was achieved using wooden spatulas whilst copious irrigation was performed during the exothermic phase of cement curing. The spinal musculature did not require partial excision. Closure was otherwise routine.

Postoperative care

Postoperative analgesia was provided by the administration of methadone (0.04 mg/kg, IM) repeated every four hours for 24 hours. Analgesia was continued on an individual basis after 24 hours using buprenorphine (0.01 mg/kg, IM). Meloxicam (0.1 mg/kg P.O. SID) was dispensed for seven to 10 days. Physical and neurological examinations were performed daily on all cats. Manual bladder assessment was performed three times daily until the cat was able to voluntarily urinate. All the cats were discharged from the hospital only after they were able to ambulate and urinate voluntarily and did not require injectable analgesic medications.

Follow-up examination

Full orthopaedic and neurological examinations were performed six weeks postoperatively. Implant positioning, implant stability and osseous fusion were radiographically re-evaluated with the cat under deep sedation (medetomidine hydrochloride, 0.01 mg/kg intravenously [IV] and butorphanol, 0.1 mg/kg IV).

Owner visual analogue scale questionnaire

A visual analogue scale questionnaire (0 to 10) was submitted to all owners at least one year after the procedure was performed. The questions were adapted from a previously validated questionnaire assessing feline-specific outcome measures after treatment of osteoarthritis (Appendix Table 1 - available online at www.vcot-online.com) (2). The questionnaire allowed collection of data regarding activity and behaviour. A score of 0 corresponded to a normal, pain-free ability to perform the activity or behaviour and a score of 10 corresponded to extreme abnormality or pain when performing the activity or behaviour. Overall outcome was assessed based on the median score achieved after the analysis of all responses. Arbitrarily, a median of < 2 points = excellent outcome, 2-3 = good outcome, 4-6 = suboptimal outcome and >6 = poor outcome.

Results

Five cats fulfilled the inclusion criteria. A total of 1296 cats were seen during the study period, resulting in a 0.38% incidence of cats with degenerative lumbosacral stenosis in our hospital population (orthopaedic and neurosurgical referrals). Breeds included Domestic Shorthaired (n = 2), Maine Coon (n = 1), Bengal (n=1), and Domestic Longhaired (n = 1). All five cats were male (3 neutered). Age ranged between seven to 15 years (median 108 months) and body weight ranged from 3.9 to 7.3 kg (median 6.4 kg). Median duration of clinical signs was 150 days (range 2 to 365 days). The nature and severity of the clinical signs varied among cats; however, hyperaesthesia, evident as severe discomfort on palpation of the lumbar spine or spontaneous vocalisation when exercising, was a common finding for all cats. In all cases, the owners also reported reluctance of their cat to jump onto objects such as a sofa, bed or chair. Of the five cats, two were presented with neurological deficits; one had delayed proprioception of one of the pelvic limbs, with absent withdrawal and patellar reflex, and the second had a flaccid

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Vet Comp Orthop Traumatol 1/2013

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All cats were able to consciously urinate. Four cats were presented with unilateral pelvic limb lameness and one had bilateral pelvic limb lameness.

Moderate to severe spondylosis and sclerosis of the end plates of the L7 and S1 vertebral bodies were radiographically evident in four cats. Spondylolisthesis with ventral subluxation of the vertebral body of the sacrum and narrowing of the spinal canal at the level of the slip was evident in three cats. One of these three cats had concomitant lumbosacral intervertebral disc space collapse, with hypertrophy of the articular facets at L7-S1. Case 5 had been treated for traumatic coxofemoral luxation by right femoral head and neck excision two years prior to presentation.

Dorsal decompressive laminectomies followed by placement of miniature pins and bone cement was successfully performed at the L7-S1 intervertebral disc space in all cats. Changes consistent with Hansen type II disc protrusion were confirmed intra-operatively in all cases except one (Case 2) where the nerve root impingement was caused by distortion of the spinal canal due to the lumbar transitional vertebrae (disc protrusion was deemed minor in this cat). Intra-operative complications were not encountered and postoperative radiographic assessment confirmed satisfactory implant positioning in all cats (Figure 3).

Median hospitalization time was three days (range 2–4 days). No deterioration of clinical signs was noted post-surgery in any of the cats. Veterinary assessment confirmed that lameness had resolved in four out of five cats within three days and in one cat by six weeks postoperatively. Radiography at six weeks revealed maintenance of the previous position and integrity of all implant constructs. Bone union progression was not evident at this stage in any of the cases. Final clinical follow-up examination was performed after a median of 60 days post-operatively (range 42 to 90 days). On examination, no orthopaedic abnormalities, neurological deficits or hyperaesthesia were evident.

Magnetic resonance imaging of the lumbosacral spine was performed in all cases. This revealed changes consistent with Hansen Type II intervertebral disc degeneration, with dorsal bulging of the annulus fibrosus causing ventral compression of the cauda equina or spinal nerve roots (Figure 2). Transverse images at the lumbosacral junction revealed that four cases were affected by uni- or bilateral encroachment of the L7 nerve roots caused by foraminal disc herniation (with epidural fat signal replaced by hypointense disc tissue at the level of the neuroforamen) and that one cat (Case 2) was affected by unilateral foraminal stenosis. This cat also had a type III lumbar transitional vertebrae (with broad attachment of the right transverse process to the ilium and to the wing of the sacrum) (22). This deformity caused distortion of the spinal canal and dorsal compression of the nerve roots, predominantly on the right side.

Figure 2 Sagittal and transverse magnetic resonance images of the lumbosacral joint space (Case 1). The T2-weighted sagittal images demonstrate severe disc bulging at L7-S1 (white empty arrow) and, on the transverse images, absence of fat signal at the level of the L7 nerve roots replaced by a hypotense signal of the protruding disc (white thin arrows) indicating bilateral severe encroachment of the L7 nerve roots.

Figure 3 A) Lateral and ventrodorsal radiographs of the lumbosacral junction of Case 1. Note the end plates sclerosis and the ventral and abaxial spondylolisthesis at L7-S1. B) Postoperative lateral and ventrodorsal radiographs of the lumbosacral junction after stabilisation using miniature interface pins and polymethylmethacrylate. C) Six weeks follow-up radiographs, confirming persistent satisfactory implant positioning.
were noted. No complications related to the bolus of PMMA and the thin soft tissue cover was noted at that point or has been reported by the owners. All owners reported resumption of normal activity including running and jumping and no further signs of pain.

The long-term visual analogue scale questionnaire was returned by four owners. Median questionnaire follow-up time was 24 months postoperatively (range 12-41 months). After analysis of all responses, the outcome was classified as excellent in two cats and good in the other two cats (Table 1). One cat that had an excellent outcome (Case 3) had been euthanized one month prior to compilation of the questionnaire for hepatic neoplasia. The owner of this cat had completed the questionnaire considering the last month before the cat was affected by the unrelated illness. This was the only cat still being treated with oral meloxicam due to pre-existing elbow arthritis.

**Discussion**

The surgical treatment for cats with degenerative lumbosacral stenosis by dorsal laminectomy and internal stabilization of the lumbosacral was straightforward to apply and effectively restored normal or nearly normal activity in all cats where long-term follow-up data were available.

Degenerative lumbosacral stenosis is a complex problem and is characterized by Hansen type-II disc protrusion, hypertrophied soft tissues (ligamentous and synovial structures), osteophytosis of the lumbosacral joint, lumbosacral ventral spondylosis, spondylolisthesis and instability (15). These are all common findings in cats that are presented with clinical signs attributable to lumbosacral stenosis (4). Sacrocaudal dysgenesis and associated malformation have also been reported and, depending on the degree of cauda equina or spinal cord compression, they can account for more severe neurological signs such as paraparesis, paraplegia, megaocolon, atonic bladder and urinary or faecal incontinence (23). Early in the disease course, the neurological examination indicates lameness without paresis, normal to marginally slow postural reactions, and normal spinal reflexes. In some animals, loss of antagonist muscle tone with significant sciatic nerve deficits may result in the appearance of a falsely exaggerated patellar reflex (termed patellar pseudohyperreflexia) (24). At the moment of the first neurological examination Case 2 appeared to have absent patellar reflex on the right pelvic limb; this finding was no longer present eight days later when the cat was re-admitted prior to surgery (the patellar reflex was considered normal at that stage). This is the same case with distortion of the spinal canal and compression of the nerve roots, predominantly on the right side, due to a lumbar transitional vertebra. The reason for the absence of the patellar reflex during the first examination is unknown.

Degenerative lumbosacral stenosis occurs most commonly in middle-aged and medium-to-large breed dogs (7, 18). The age range reported in cats is similar to dogs but no feline breed predisposition to lumbosacral disease has been reported (1, 4, 5, 8-17). In our case series, the median age of the five cats (9 years) was similar to the mean age reported in previous studies on feline intervertebral disc disease. Radiographic changes noted in our study were similar to those described for dogs with degenerative lumbosacral stenosis; these included lumbosacral spondylolisthesis deformans, intervertebral disc space collapse, endplate sclerosis, articular facet hypertrophy, and spondilitis with cranioventral tipping of S1 relative to L7 (7, 18, 25, 26). Bone union was not evident in any of the cases at the level of the lumbosacral joint at the last radiographic follow-up examination. However, eventual lumbosacralankylosis is expected with progressive ventral bridging of the L7-S1 vertebral bodies and loss of intervertebral disc space.

To our knowledge, this is the first study where diagnosis of feline degenerative lumbosacral stenosis was supported by MRI findings. In dogs, MRI has already been proven to be superior to other imaging techniques because it provides more detailed information on intervertebral disc degeneration, dural sac and nerve root displacement as well as loss of epidural fat (which is important in order to assess the degree and location of intervertebral foraminal compression) (6). Based on the authors’ experience, the use of MRI coupled with a high index of clinical suspicion based on neurological examination provided an excellent diagnostic tool for the diagnosis of cauda equina syndrome in cats.

Non-surgical management of cats with degenerative lumbosacral stenosis consists of the use of non-steroidal anti-inflammatory drugs, body weight reduction, and exercise restriction (2). Lumbosacral epidural injections of corticosteroids have also recently been reported as treatment method in dogs (27). However, the efficacy of this treatment in cats has never been reported. Long-term use of non-steroidal anti-inflammatory drugs is a potentially hazardous option in cats because of the increased potential for nephrotoxicity in this species (28). For this reason, surgical intervention is indicated in cats that fail to respond to a short period of non-surgical management.

Numerous surgical techniques have been reported to treat degenerative lumbosacral stenosis in dogs but there is a paucity of reports documenting surgical technique and outcome in cats (18, 19, 26, 29). Lumbosacral hypermobility or instability has recently been described in one cat that was subsequently treated by dorsal stabilization using screws and PMMA (4). However, before that case report, lumbosacral stabilization in cats had not been described in the veterinary literature. It has been suggested that vertebral osteophytes are often found in conjunction with narrowing of the intervertebral space and sclerosis of the end plate, both of which are associated with instability caused by a slowly degenerating disc (30). Ventr al subluxation of the vertebral body of the sacrum in relation to the body of L7 has also been considered to be a sign of lumbosacral instability in dogs (29).

Objective evaluation of vertebral instability at level of lumbosacral joint in cats has not been reported. Instability at the lumbosacral joint leads to proliferation of the surrounding soft-tissue structures causing hypertrophy of the interarcuate ligament, epidural fibrosis, and thickening of the capsules of the articular processes, followed by cartilaginous end plate thickening and bony proliferation development, such as osteophytes and ventral spondylosis (25, 29). Furthermore, it has been proved that...
stability is negatively affected in all three directions of motion in the healthy lumbosacral spine of dogs after surgical procedures such as dorsal laminectomy and nucleotomy alone (31). This is corroborated by several studies that showed less favourable results in working dogs (because the higher demands in performance), lack of restoration of propulsive forces on gait assessment using force-plate analysis and high recurrence rate of clinical signs (26, 32, 33). Based on all the above and on the author’s experience with previous canine patients, we feel that stabilization of the lumbosacral joint plays an important role in the surgical treatment of degenerative lumbosacral stenosis in cats and dogs. Fixation-fusion of the lumbosacral segment has the potential to delay progression of the disease, and simultaneously eliminate dynamic nerve root compression within the neuroforamen (25).

Stabilisation of the lumbosacral articulation in dogs can be achieved by placement of screws through the articular processes of L7-S1 and into the body of the sacrum, or by the use of pedicle screws connected by rods or screws and PMMA (4, 34, 35). These techniques may be inappropriate in cats due to the small size of the articular facets. In contrast, positive-profile pins were found to be useful in these cats. Advantages include the small pin diameter that suits smaller osseous targets, excellent bone holding strength and increased cement bonding due to the central area of the pin shaft that is factory-roughened to enhance the interface between the acryl frame and pin. The necessity to bend the pin’s end to improve stability and holding power in the cement is therefore avoided. Common complications related to the use of pins and cement in dogs include implant loosening and implant migration (36). However, none of these complications were noted in this case series.

There are not any validated measures available to assess clinical outcome after spinal or orthopaedic surgery in cats. In dogs, surgical outcome assessment is a rapidly expanding science. Validated owner questionnaires can be coupled with objective veterinary assessment and kinetic or kinematic gait analysis to test the efficacy of orthopaedic or neurosurgical intervention (37, 38). Compared with dogs, feline kinetic and kinematic gait analysis is significantly more difficult. For this reason, we chose a combination of veterinary assessment and detailed owner evaluation as our outcome measures. The questions we submitted to the owners were extrapolated from a recent owner questionnaire that was the first validated subjective owner assessment instrument for the measurement of feline degenerative joint disease-associated clinical signs (2). Case 5 scored high points when the owner was asked about vocalization when handled and spontaneous vocalization; this is the same case that had a femoral head and neck excision performed two years previously following a road traffic accident. Further telephonic conversation was made to investigate the reasons for this; the owner believes that the degree of vocalization was part of the normal temperament of the cat and she did not believe it was associated with manifestation of pain. This was confirmed by the low median points that the cat scored when the other daily activities were assessed by the owner.

The major limitation of this report is the lack of a control group of cats managed non-surgically or by alternative surgical techniques such as dorsal laminectomy or dorsal stabilisation in isolation. We postulate that cauda equina compression and neuroforaminal stenosis were the two major factors contributing to the presence of clinical signs in these cats. It is intuitive that dorsal laminectomy and discectomy would address the pain related to compression of the cauda equina and that dorsal stabilisation would address further instability of the lumbosacral area. However, it is not possible to confirm from this cohort of cats whether this is the case, or whether the improvements were partially or wholly attributable to other components of the surgical technique or peri-operative management. Given the retrospective nature of this study, the lack of preoperative visual assessment and detailed owner evaluation as part of the inclusion criteria would address the pain related to compression of the cauda equina.

Based on the outcomes in these cases, we conclude that this combination of techniques with dorsal laminectomy and dorsal stabilisation using pins could be an effective method for management of clinical signs in other cats affected by lumbosacral intervertebral disc disease.

Conflict of interest

The Authors report no conflict of interest. No external financial support or funding was received for the preparation of this manuscript.

References