Long-term functional outcome of dogs with severe injuries of the thoracolumbar spinal cord: 87 cases (1996–2001)

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Objective—To determine long-term (> 6 months) outcome of dogs with paraplegia and loss of hind limb deep pain perception (DPP) resulting from intervertebral disk herniation or trauma.

Design—Retrospective study.

Animals—87 dogs.

Procedure—Outcome was determined as successful or unsuccessful. The association of neuroanatomic localization, breed, age, weight, sex, and (for dogs with intervertebral disk herniation) speed of onset of signs and duration of paraplegia prior to surgery with outcome was evaluated. Owners were contacted by telephone to identify long-term health problems.

Results—Nine of 17 dogs with traumatic injuries were treated, and 2 regained the ability to walk; none of the 17 dogs regained DPP. Sixty-four of 70 dogs with intervertebral disk herniation underwent surgery; 9 (14%) were euthanatized within 3 weeks after surgery (7 because of ascending myelomalacia), 37 (56%) regained DPP and the ability to walk, 7 (11%) regained the ability to walk without regaining DPP, and 11 (17%) remained paraplegic without DPP. Outcome was not associated with any of the factors evaluated, but speed of recovery of ambulation was significantly associated with body weight and age. Fifteen (41%) and 12 (32%) dogs that regained DPP had intermittent fecal and urinary incontinence, respectively.

Conclusions and Clinical Relevance—Results suggested that the prognosis for paraplegic dogs without DPP because of trauma was guarded, while dogs with disk herniation had a better chance of recovering motor function. A third of the dogs that recovered motor function had intermittent incontinence. Persistent loss of DPP did not preclude recovery of motor function, but such dogs remained incontinent. (J Am Vet Med Assoc 2003;222:762–769)

Severe spinal cord injury is an important cause of permanent disability or death in dogs. Dogs with incomplete spinal cord injuries (ie, without functional transection of the spinal cord) resulting from intervertebral disk herniation or vertebral fracture typically have a good prognosis for recovery following decompressive or stabilizing surgery. In contrast, dogs with injuries that result in complete transection of the spinal cord are considered to have an extremely grave prognosis for return of hind limb function.

Unfortunately, it is difficult to establish whether the spinal cord is permanently functionally transected at the time of injury. One key indicator of injury severity is the presence or absence of deep pain perception (DPP) in the hind limbs. Deep pain perception is carried by small-diameter axons in diffuse multisynaptic tracts (the spinoreticular, propriospinal, and possibly spinothalamic tracts) adjacent to the spinal cord gray matter. The presence of DPP indicates a good prognosis for recovery of function, whereas the absence of DPP is typically interpreted as an indication of functional spinal cord transection at the time of testing. However, this does not necessarily imply permanent functional transection of the spinal cord, as some dogs that lose hind limb DPP following a spinal cord injury may regain sensation and make a good functional recovery. This presents a dilemma for owners of dogs with spinal cord injuries and loss of hind limb DPP who must decide whether to undertake expensive surgical treatment while unsure of the outcome.

Dogs that lose hind limb DPP as a result of vertebral fracture or luxation reportedly have a poor prognosis for recovery of motor function, with < 10% of dogs expected to recover. However, most dogs with injuries this severe are euthanatized at the time of initial examination, making it difficult to draw conclusions about the long-term outcome of dogs with these types of injuries that receive treatment. Previous studies examined prognostic indicators for recovery in such dogs. One found that the speed of onset of clinical signs was related to outcome, with a peracute onset of clinical signs being associated with a worse outcome. The other found that the amount of spinal cord swelling evident on a myelogram correlated with outcome. However, results of these studies were conflicting, and both were limited by inclusion of low numbers of dogs. In addition, there is little information available on factors associated with speed of recovery in dogs that regain motor function or the incidence and type of long-term health problems associated with severe spinal cord injuries.

Accordingly, in this study, we evaluated the long-
term outcome and secondary health problems of paraplegic dogs that had lost hind limb DPP as a result of a traumatic injury or intervertebral disk herniation and evaluated factors potentially associated with recovery of function. The specific aims of this study were to determine the long-term (> 6 months) outcome of dogs with intervertebral disk herniation or spinal cord trauma severe enough to result in paraplegia and loss of hind limb DPP, to identify factors associated with recovery of hind limb function and speed of recovery of hind limb function, and to determine the incidence of long-term health problems (ie, urinary and fecal incontinence, urinary tract infection, and recurrence of signs of pain and hind limb paresis).

Criteria for Selection of Cases
Medical records of dogs examined at the North Carolina State University Veterinary Teaching Hospital from 1996 through 2001 were reviewed. Dogs were included in the study if they had had an acute onset of paraplegia resulting from intervertebral disk herniation or trauma, did not have DPP in the hind limbs at the time of initial examination, and had been followed up for at least 6 months. Absence of DPP was defined as a lack of conscious response (eg, crying, looking round, shifting weight, or similar reaction) to the application of heavy pressure to the hind limb digits and tail with forceps. Dogs with intervertebral disk disease were included in the study only if a complete workup, including a serum biochemical panel, a CBC, CSF analysis, and computed tomography of the spine or thoracolumbar myelography had been performed. Dogs with trauma had a minimum workup that included a serum biochemical panel, a CBC, and plain spinal radiographs. Additional workup (if indicated) included either thoracolumbar myelography or computed tomography of the spine.

Procedures
Dogs with intervertebral disk disease underwent hemilaminectomy to decompress the spinal cord and fenestration of, at a minimum, the affected disk. In most dogs, the intervertebral disks from T11-12 to L2-3 were prophylactically fenestrated. Postoperatively, dogs were given oxymorphone (0.05 mg/kg [0.02 mg/lb], IV, as needed), hydromorphone (0.05 mg/kg, IV, as needed), or fentanyl (administered by application of patches designed to release fentanyl at a rate of 2 to 4 µg/kg [0.9 to 1.8 µg/lb] for 3 days) for pain relief. Diazepam (0.5 mg/kg [0.23 mg/lb], PO, 20 minutes prior to bladder expression) and phenoxylbenzamine (0.5 mg/kg, PO, q 12 h) were used to aid with bladder expression when indicated. Treatment with antimicrobials selected on the basis of results of bacterial culture and susceptibility testing was instituted in dogs with urinary tract infections.

In dogs with spinal cord injuries resulting from trauma, management was either conservative (cage rest for 4 to 6 weeks, with or without external splinting) or surgical. Surgery involved stabilization of the affected vertebrae using screws and polymethyl methacrylate with additional decompression by laminectomy, if indicated. Management of pain and bladder function was the same as for dogs with disk herniations.

For the present study, information obtained from the medical record included signalment, history, initial clinical signs, diagnosis, and treatment. For dogs with intervertebral disk disease, time for the dog to lose the ability to ambulate and time that elapsed between the onset of paraplegia and decompressive surgery were determined from the medical records.

Dogs in the 2 groups (trauma vs intervertebral disk disease) were classified as having been euthanatized at the time of initial examination, as having been euthanatized within 1 month after initial examination, as having recovered DPP, or as having never recovered DPP despite being maintained by the owners for at least 2 months after initial examination. For dogs that were euthanatized, reason for and timing of euthanasia were recorded. For all dogs, time (1 week, 1 to 2 weeks, 2 to 4 weeks, or > 4 weeks) after injury for recovery of DPP and for a return of the ability to walk without support and without falling were also recorded. Outcome was classified as successful (regained DPP and the ability to walk without support and without falling) or unsuccessful (did not regain DPP or the ability to walk without support and without falling) with persistent absence of DPP. For purposes of statistical analyses of factors associated with outcome, dogs with this third outcome were classified as having an unsuccessful outcome, unless noted otherwise. Owners of dogs maintained for > 6 months were questioned about the incidence of fecal and urinary incontinence, urinary tract infections, signs of back pain, recurrent paresis, and any other health problems they had encountered.

Statistical analyses—Data for dogs with spinal cord injuries secondary to trauma were analyzed separately from data for dogs with intervertebral disk disease. For each group, the percentage of dogs with a successful outcome was calculated. Because none of the dogs with spinal cord injuries secondary to trauma recovered DPP for this analysis, dogs were considered to have had a successful outcome if they recovered the ability to walk without support and without falling, even without recovery of DPP. Percentages were compared between groups with a Fisher exact test; a value of \( P < 0.05 \) was considered significant.

To allow for comparison with results of a previous study of prognostic factors for a successful outcome in dogs with intervertebral disk disease, the onset of clinical signs in dogs with intervertebral disk disease in the present study was classified as peracute (< 1 hour), acute (1 to 24 hours), or gradual (> 24 hours). Duration of paraplegia prior to surgery was classified as < 12 hours, 12 to 24 hours, 24 to 48 hours, or > 48 hours. Age was classified as ≤ 4 years or > 4 years. Body weight was classified as < 10 kg (22 lb), 10 to 20 kg, or > 20 kg (44 lb). Breed was classified as Dachshund or other. Neurolocalization was classified as upper (T10 through L2) or lower motor neuron (L3 through L7) disease.
The association between various individual variables and recovery of the ability to walk was evaluated by use of logistic regression; adjusted odds ratios and corresponding 95% confidence limits were established from the β-coefficient for each variable. Odds ratios significantly > 1 were considered indicative of an association with recovery of the ability to walk.24 Multivariable regression was not performed, because no variables were identified in bivariate analyses as being significantly associated with recovery of the ability to walk.

Associations between age and weight and the time it took dogs to begin walking after surgery were evaluated by means of Kaplan-Meier analysis.20 The log-rank test was used to determine statistical significance, with values of P < 0.05 considered significant.

Results

Eighty-seven dogs met the criteria for inclusion in the study, including 17 dogs with a traumatic injury and 70 with intervertebral disk herniation.

Dogs with traumatic spinal cord injuries—The 17 dogs with acute traumatic spinal cord injuries included 5 mixed-breed dogs and 1 each of the following: Dachshund, Golden Retriever, Airedale Terrier, Doberman Pinscher, Toy Poodle, Cocker Spaniel, English Springer Spaniel, Australian Cattle Dog, Yorkshire Terrier, Beagle, Border Collie, and Rottweiler. The dogs ranged from 1 to 13 years old, but most were ≤ 4 years old (Fig 1). Nine dogs were male (8 were sexually intact), and 8 were female (2 were sexually intact). The site of injury ranged from T8 to L5 (Fig 2).

Eight dogs were euthanatized at the time of initial examination because of severe displacement of the fracture fragments or additional severe injuries (eg, displaced pelvic fracture with rectal tears). Owners of the remaining 9 dogs chose to pursue treatment; none of these 9 dogs had clinically important injuries other than the spinal cord injury. Owners of 2 dogs with displaced vertebral fractures opted for conservative management (application of an external splint and administration of analgesics). Five dogs had unstable vertebral fractures or luxations with minimal displacement. Surgery was performed in 2 of these 5 dogs, and 1 of the 2 regained the ability to walk. In the remaining 3 dogs, the owners opted for conservative management; none of these dogs regained the ability to walk. One dog had a fracture of the lateral pedicle of the fifth lumbar vertebra and underwent decompressive surgery; this dog regained the ability to walk. One dog that had been hit by a car did not have any evidence of a vertebral fracture or luxation, but a focal area of edema was identified in the spinal cord on T2-weighted magnetic resonance images. The dog underwent physical therapy for the subsequent year but did not regain the ability to walk.

None of the 9 dogs that were treated for acute traumatic spinal cord injuries regained hind limb DPP, but 2 regained the ability to walk. Both of these dogs could wag their tails voluntarily 1 month after the injury, although they were still paraplegic at that time. The dog with a fracture of the fifth lumbar vertebra started to walk 2 months after surgery and continued to walk by hopping with both hind limbs together and the stifle joints extended. The other dog improved more slowly and was first seen to stand 3 months after the injury. However, it took 6 months for the dog to recover the ability to walk, albeit with a markedly disconnected gait. The dog continued to show improvements in motor function > 24 months after injury. Both dogs were able to urinate and defecate but had intermittent fecal and urinary incontinence.

Two of the 7 dogs that did not regain the ability to walk were euthanatized 6 weeks and 26 months after injury because of decubital ulcers. One dog died of congestive heart failure 1 year after injury. The remaining 4 dogs were still alive > 2 years after injury but were unable to walk and were incontinent.

Dogs with intervertebral disk disease—Of the 70 dogs with severe spinal cord injuries secondary to intervertebral disk disease, 46 were Dachshunds. In addition, there were 4 Cocker Spaniels, 4 mixed-breed dogs, 3 Basset Hounds, 2 Beagles, 2 Pekingese, 2 Jack Russell Terriers, and 1 each of the following breeds: Toy Poodle, Pug, Shih Tzu, Bichon Frise, Rottweiler, German Shepherd Dog, and Labrador Retriever. There were only 7 dogs that weighed > 20 kg (the 3 Basset Hounds, Rottweiler, German Shepherd Dog, and Labrador Retriever and a large mixed-breed dog). Dogs ranged from 2 to 11 years old, but most were between 4 and 8 years old (Fig 3). There were 30 spayed females, 6 sexually intact females, 21 castrated males, and 13 sexually intact males. Site of disk herniation ranged from T10-11 to L5-6 (Fig 4); several dogs had disk material at more than 1 site.

Six dogs were euthanatized at the time of initial examination at the owner’s request; the remaining 64 underwent surgery. Of these, 9 were euthanatized with-
in 1 month after surgery. Seven of the 9 were euthanatized within 1 week after surgery because of suspected (n = 6) or histologically confirmed (1) ascending myelomalacia. In the 6 dogs in which ascending myelomalacia was suspected, the diagnosis was made on the basis of cranial movement of the level at which the cutaneous trunci reflex could be elicited during the initial 5 to 7 days after injury, development of lower motor neuron signs in the hind limbs, and subsequent development of tetraparesis. The remaining 2 dogs were euthanatized within 3 weeks after surgery at the owners’ request because of a lack of improvement.

Thirty-seven of the 64 (58%) dogs that underwent surgery regained DPP and the ability to walk. Mean follow-up time for these dogs was 21 months (range, 6 to 84 months). Fifteen of the 37 (41%) regained DPP within 1 week after surgery, 14 (38%) during the second week after surgery, 7 (19%) during the third or fourth week after surgery, and 1 (3%) 36 weeks after surgery. Mean time to regain the ability to walk was 7.5 weeks (range, <1 to 36 weeks). However, 23 of the 37 (62%) dogs were walking within 4 weeks after surgery, 11 (30%) between 4 and 12 weeks after surgery, and 3 (8%) >12 weeks after surgery. The 3 dogs that took >12 weeks to regain the ability to walk without support and without falling were medium- to large-breed dogs (a Rottweiler, a Labrador Retriever, and a Cocker Spaniel).

Fifteen of the 37 (41%) dogs that regained DPP and the ability to walk had intermittent fecal incontinence. However, in all but 4 of these dogs, the incontinence was infrequent and not perceived to be an important problem by the owners. Owners of these dogs reported that their pets appeared to be aware of the need to defecate but were not always able to wait until able to go outside. Accidents were more likely to occur when dogs were excited or left in the house for extended periods. In all dogs, this reflected a change in behavior that coincided with the spinal cord injury. Four of the 37 (11%) dogs had severe fecal incontinence; these dogs defecated in the house every day and either did not seem aware of the need to defecate or could not get outside in time. In all 4 dogs, no other cause of the incontinence could be identified. Only 2 owners called to inform us of the problem; the other 2 owners only revealed the problem when questioned and did not feel that it was important. None of the dogs had evidence of lower motor neuron incontinence (decreased perineal reflex or anal tone), and all 4 dogs had disk herniations in the region of the thoracolumbar junction.

Twelve of the 37 (32%) dogs that regained DPP and the ability to walk had mild urinary incontinence. These dogs dribbled urine infrequently in the house. All of the dogs with urinary incontinence had mild fecal incontinence. Nine of the 37 (24%) dogs had a urinary tract infection during the 3 months after surgery, and 2 (5%) had recurrent urinary tract infections. Six dogs had a recurrence of neurologic signs. Two of these 6 dogs had another episode of back pain that responded to rest and administration of anti-inflammatory drugs. One dog had an acute onset of paraparesis 7 years after the initial disk herniation and underwent hemilaminectomy to remove herniated disk material. The second disk herniation occurred at a site that had not been fenestrated at the time of the initial surgery. One dog mutilated its penis during the first week after surgery; the tip of the penis had to be amputated, after which the dog had no further problems.

The remaining 18 (28%) dogs that underwent surgery did not regain DPP. Four of these dogs were euthanatized 2, 4, 9, and 36 months after injury because of a lack of improvement and fecal and urinary incontinence; 1 dog died as a result of an attack by another dog 6 months after injury; 1 dog was euthanatized 9 years after injury because of pyelonephritis; and 5 dogs had persistent paraplegia >12 months after injury. The remaining 7 dogs regained the ability to walk despite a lack of DPP. Mean time to regain the ability to walk in these 7 dogs was 37.6 weeks (range, 16 to 72 weeks). All 7 dogs had a voluntary tail wag (in response to a positive stimulus, such as the owner entering the room) 1 month after injury. All 13 dogs with persistent absence of DPP that were still alive at the time of this study had urinary and fecal incontinence and had had recurrent urinary tract infections. There were no recurrences of weakness in the dogs that regained the ability to walk or of signs of back pain in any of these dogs.

Analysis of factors associated with a successful outcome—A successful outcome was obtained in 44 of 64 (69%) dogs with intervertebral disk disease that underwent surgery, although only 37 of the 64 (58%) dogs regained DPP. None of the factors evaluated were associated with whether dogs would regain the ability to walk. In dogs that regained DPP and the ability to walk, Kaplan-Meier analysis revealed that both age and weight were significantly associated with time required to regain the ability to walk (Fig 5 and 6). Dogs with intervertebral disk disease had a signifi-
Discussion

Results of the present study indicate that for dogs with severe spinal cord injuries (ie, paraplegia with loss of DPP), the prognosis for recovery of motor function was significantly worse for dogs that had a traumatic spinal cord injury than for dogs with traumatic spinal cord injuries (2 of 9 dogs regained the ability to walk). This was not surprising in that dogs that have a vertebral fracture of luxation are likely to have spinal cord injury as a result of intervertebral disk herniation. This was not surprising in that dogs that have a vertebral fracture or luxation are likely to have spinal cord injury as a result of intervertebral disk herniation.

Discussion

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2 dogs did regain the ability to walk albeit with an unusual gait, intermittent incontinence, and a prolonged recovery time. Neither of these dogs had severely displaced fractures, and both underwent surgery (1 to remove a fractured lateral pedicle that was compressing the spinal cord and the other to stabilize the spine). Although the number of dogs examined was too low to draw statistically accurate conclusions, these findings suggest that in dogs with nondisplaced vertebral fractures and loss of DPP, there is a small chance of recovery of motor function, although recovery of continence and DPP is unlikely.

Recovery of motor function in dogs with persistent absence of DPP could either indicate development of spinal reflex walking or survival of axons across the injury site. Spinal reflex walking is believed to originate from local spinal circuits and has been shown to develop in adult dogs, cats, and rodents following spinal cord transection. There is a clinical report of spinal reflex walking in dogs, but these dogs became nonambulatory following transection of the spinal cord above the level of the original injury, suggesting that ambulation was dependent on intact axons crossing the region of the original spinal cord lesions. In both dogs in the present study with acute traumatic spinal cord injuries that regained the ability to walk, the first sign of improvement was a voluntary tail wag, which was evidence of descending influence from higher centers. The tail wag was determined to be voluntary, because it occurred in response to the owner's presence or voice. This suggests that although these dogs did not have DPP in the hind limbs, their spinal cord injuries were not complete. In previous studies of animals with experimentally induced acute spinal cord injury, such as the weight drop model, the induced spinal cord lesion is centered on the gray matter with relative sparing of the peripheral white matter. Even with severe injury, a peripheral rim of subpial axons is typically spared, and it has been shown in cats and rats that sparing of as few as 3 to 10% of descending axons is sufficient to drive the local circuits that produce basic locomotion. For this reason, studies on regeneration of spinal cord axons commonly use experimental protocols in which a 2- to 4-mm section of the spinal cord is removed or gentle aspiration of the cord following transection is used to create a cavity. Because most of the axons that convey DPP lie close to the gray matter in the propriospinal and spinoreticular tracts, it is conceivable that they could be destroyed following a severe injury, while a narrow subpial rim of axons survive. In a previous study, spinal cords from 20 dogs that had vertebral fractures were studied. Fourteen of the dogs were paraplegic without DPP prior to euthanasia, but in 6 of these dogs there was still some continuity of the spinal cord histologically. Although the persistent absence of DPP clearly indicates a severe injury, it should not be taken to indicate complete anatomic spinal cord transection. This is an important concept both clinically and experimentally, as dogs with naturally occurring injuries are now used in spinal cord regeneration studies. Dogs can regain the ability to walk even without treatment several months after a severe spinal cord injury despite persistent absence of DPP.
Seventeen of 64 (11%) dogs with intervertebral disk disease that underwent surgery in the present study developed ascending myelomalacia and were euthanatized. The diagnosis was confirmed at necropsy in only 1 of these dogs, but the progression of clinical signs in all 17 was highly suggestive. We were surprised at the number of dogs in which ascending myelomalacia developed, and a review of the literature revealed a range in the reported incidence of this problem. For example, in a study of 9 dogs with absence of DPP that underwent fenestration alone, 2 developed ascending myelomalacia. Some studies do not specifically mention ascending myelomalacia but report that some dogs died or were euthanatized within 2 weeks after surgery because of neurologic deterioration. Another study reported that no dogs developed ascending myelomalacia, but 35% of dogs were euthanatized at surgery on the basis of gross appearance of the spinal cord. Many surgeons perform a durotomy and inspect the spinal cord at the time of surgery. While this practice appears to have reduced the incidence of ascending myelomalacia at some institutions, it is possible that some dogs may be euthanatized erroneously on the basis of gross spinal cord appearance. A larger study reported that 9% of dogs with an absence of DPP developed ascending myelomalacia, suggesting that an incidence of approximately 10% is a consistent finding in dogs with the most severe grade of injury secondary to intervertebral disk herniation.

Thirty-seven of 64 (58%) dogs with intervertebral disk disease that underwent surgery in the present study regained DPP. Previously reported percentages of dogs that recover following dorsal or hemilaminectomy range from 25 to 76%. This wide range probably reflects the fact that dogs in each study had different spectrums of injury severity. Typically, dogs that do not have hind limb DPP are all assigned to the same clinical grade, but this grade clearly encompasses a wide range of injury severity, as some dogs make a full recovery and others remain permanently paraplegic. Twenty-nine of the 37 (78%) dogs that regained DPP in the present study did so within 2 weeks after surgery, but only 1 dog regained DPP > 1 month after surgery. As all dogs that regained DPP also regained the ability to walk, evaluation of dogs for DPP 1 month after surgery may be useful in determining the prognosis for recovery. Dogs that regained DPP took a mean of 7.5 weeks to walk again, but 23 of 37 (62%) dogs were walking within 4 weeks after surgery. Age and weight were both significantly associated with time taken to walk, which was consistent with findings of another study involving large-breed dogs with less severe spinal cord injuries. In dogs with loss of DPP secondary to intervertebral disk disease, duration of paraplegia prior to surgery and the speed of onset of clinical signs have been examined to determine whether they were associated with outcome in the hopes that these factors could be useful in establishing prognosis prior to surgery. In contrast to results of 1 of these studies, we were unable to show an association between poor prognosis and a peracute onset of signs in the present study. This could be a result of the difficulty in determining the exact speed of onset of signs in many dogs. However, results of our study do suggest that advising an owner of a poorer prognosis on the basis of speed of onset of clinical signs should be avoided. Outcome was also not associated with duration of paraplegia prior to surgery in the present study or whether signs were evidence of an upper versus lower motor neuron neuroanatomic localization. Although it is intuitive that delaying surgery worsens outcome, the evidence from the present and other studies suggests that the converse is true. This could reflect in part the relatively low numbers of dogs that are treated surgically following a delay. It is also possible that such dogs are referred for surgery after a delay, because they had DPP when they became paralyzed but lost it later in the course of their disease secondary to a large compressive lesion rather than a concussive injury. Dogs with large compressive lesions often respond well to decompressive surgery. As it is often impossible to determine the time at which DPP is lost, it is difficult to do more than speculate about these dogs.

The lack of difference in outcome between dogs with upper versus lower motor neuron lesions in the present study was in agreement with the findings of another study that evaluated less severely injured dogs. Other factors evaluated in the present study did not appear to affect outcome. This could reflect inadequate case numbers but may also be a reflection of the crudity of our means of evaluating the severity of spinal cord injury in dogs. We conclude that we do not currently have a clinically useful means of determining, at the time of initial examination, which dogs with an absence of DPP as a result of intervertebral disk herniation will recover motor function following surgery.

Long-term follow-up of the 18 dogs with intervertebral disk disease that had persistent paraplegia with an absence of DPP revealed that none regained DPP but that 7 regained the ability to walk. Mean time to walking in these dogs was 37.6 weeks, but some dogs required as long as 72 weeks to regain the ability to walk. However, all of these dogs had long-term problems with urinary and fecal incontinence and recurrent urinary tract infections. Despite this, owners thought that their dogs were functional and happy pets. To our knowledge, similar results have not been reported previously, either because follow-up time was too short or because follow-up consisted of telephone conversations alone, and the presence or absence of DPP could not be determined. This finding highlights the fact that persistent absence of DPP does not necessarily indicate that a dog will be persistently paraplegic. The development of a voluntary tail wag was a useful early prognostic sign for recovery of motor function in such dogs. These dogs were judged to have a successful outcome according to the definitions of this study, and all owners were happy with their quality of life. However, all dogs had problems with continence and took a long time to recover. Persistent incontinence and a protracted recovery would not represent a successful outcome to many pet owners.

We were surprised at the relatively high prevalence of fecal and urinary incontinence in dogs that did
regain DPP and the ability to walk. The most common problem was fecal incontinence, with owners of 15 of 37 (41%) dogs reporting that their dogs had intermittent or severe fecal incontinence. For most of these owners, this was a minor problem that could be avoided most of the time by taking the dogs outside promptly. In most cases, the owners said their dogs appeared to suddenly realize that they needed to defecate, but could not control the urge long enough to get outside. A few owners said that their dogs did not appear to be aware that they were defecating. Fecal incontinence was a daily occurrence in only 4 of 37 dogs. All of these dogs were examined by one of the authors (NJO), and no other cause of the incontinence could be identified. All dogs had normal sphincter tone and perineal reflexes. Problems with defecation are common in people with incomplete upper motor neuron spinal cord injuries, although constipation is more common than incontinence. The normal defecation reflex is initiated by stretching of the wall of the distal portion of the colon. This results in relaxation of the internal anal sphincter and contraction of the external anal sphincter, followed eventually by relaxation of the external anal sphincter. Coordinated relaxation of the external anal sphincter and contraction of the colon, rectum, and abdominal muscles is usually mediated consciously by higher centers. All of the dogs in this study that failed to recover were able to defecate by reflex, but this could occur at any time making them difficult to manage as pets. In humans with incomplete upper motor neuron spinal cord injuries and fecal incontinence, rectal perception is impaired, there is increased rectal contraction and anal relaxation in response to low volumes of rectal distension, and there is reduced voluntary control of the external anal sphincter. Together, these factors result in a sudden need to defecate that is difficult to control in response to relatively mild rectal distension. Nearly half the dogs that regained DPP and the ability to walk had poor control of defecation when there were challenges to continence such as excitement or prolonged confinement. The descriptions given by owners suggest that these dogs suffer from the same problems as humans, but electrophysiologic evaluation is needed in these dogs to characterize this problem more fully.

Twelve of the 37 (32%) dogs that regained DPP and the ability to walk had mild urinary incontinence. In general, careful management of the dog could avoid problems. Although 9 of the 37 (24%) dogs had had a urinary tract infection during the 3 months after surgery, only 2 had had recurrent infections. In contrast, all dogs that failed to regain DPP had recurrent urinary tract infections.

There is a lot of controversy about recurrence of intervertebral disk herniation and whether fenestration decreases the rate of recurrence. In 1 study, paraparesis or pain recurred in 34% of dogs managed conservatively but did not recur in any dogs that underwent fenestration. Another study reported a recurrence of paralysis in 3% of dogs treated with hemilaminectomy and fenestration and in 20% of dogs treated with dorsal laminectomy alone. However, a separate study reported a recurrence rate of only 2.67% when dogs were treated with dorsal laminectomy alone. Comparison of results of these studies is difficult, because dogs with recurrent signs (established by telephone communication) that were not re-examined at a veterinary hospital were excluded from the latter study. If these dogs were included, the recurrence rate could have been as high as 15%. At the North Carolina State University Veterinary Teaching Hospital, we routinely fenestrate from T11-12 to L2-3 in all dogs unless there is a specific contraindication (eg, the dog has cardiovascular difficulties while anesthetized). Only 1 dog in the present study had a documented recurrence of disk herniation. This occurred 7 years after the original surgery at a site that was not fenestrated previously. An additional 3 dogs had a recurrence of paraparesis, and 2 dogs had signs of back pain, although it is uncertain whether these dogs had recurrent disk herniations. Thus, the rate of recurrence of paraparesis was 11% (4/37) among dogs that regained DPP and the ability to walk and 6.25% (4/64) in all dogs.

In summary, results of the present study suggest that in dogs, the prognosis for recovery from a spinal fracture or luxation that results in paraplegia with loss of DPP is poor. However, 2 of 9 dogs in this study did recover motor function and partial continence despite a persistent lack of DPP; neither of these dogs had a displaced vertebral fracture. The prognosis for recovery from an intervertebral disk herniation that resulted in paraplegia and loss of DPP was much better, with 37 of 64 (58%) dogs regaining DPP and the ability to walk without support and without falling, and an additional 7 dogs regaining the ability to walk despite persistent absence of DPP and incontinence. Persistent loss of DPP did not preclude recovery of motor function, and dogs that did recover motor function developed a voluntary tail wag within 4 weeks after the injury. Fecal and urinary incontinence were persistent problems in some dogs that recovered but occurred infrequently and were not perceived to be a problem by most owners.

Duragesic patch, Janssen Pharmaceutical Products LP, Titusville, NJ.

References