Intervertebral disk surgery

KEY POINTS

- Surgical treatment of a herniated disk differs depending on the type of hernia (Hansen type I hernia or “extruded” hernia/type II hernia or “contained” hernia) and the level it has reached.
- The prognosis for surgical treatment of type I herniated disks is good if deep sensitivity still exists. It is excellent for cervical herniated disks.
- Disk surgery should not be done to the detriment of the stability of the vertebral column, therefore it is always best to choose the least invasive approach from those available.
- Disk surgery must be carried out in optimal conditions. Adapted equipment must be available; a micromotor and a Kerrison rongeur are very useful.

Introduction

In veterinary medicine, intervertebral disk surgery is limited to the herniated intervertebral disk which may be situated at any level of the vertebral column, with surgical treatment differing according to the level. At the cervical level of the vertebral column, a ventral corpectomy is the technique of choice as the hernia is most often ventral. When the hernia is lateralized, a hemilaminectomy is more suitable. Thoraco-lumbar herniated intervertebral disks are nearly always ventral or ventrolateral and their treatment is based on a lateral approach. If it is a Hansen type I (Figure 1), a foramino-pediclectomy is preferably chosen over a hemilaminectomy. This is more destabilizing as an articular process has to be sacrificed. If it is a type II, a lateral corpectomy (Figure 2) is preferred. Finally, a lumbo-sacral hernia requires a classical dorsal approach by laminectomy except if it is foraminal or extra-foraminal. In these two particular cases, a transiliac technique, endoscope assisted or not, is effective.

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Recommended equipment
Surgical treatment of a herniated intervertebral disk should be made in conditions that are optimal for the surgeon and the animal. This means having adapted equipment to make access to the vertebral artery canal easier, making an atraumatic opening of the vertebral canal and controlling bleeding (Table 1).

Selection criteria for a disk surgery technique
The choice of the technique used to treat hernias is critical because it determines the quality of the result. Amongst the different techniques, you should always choose the one:

- that allows one to completely remove the herniated material, an important condition for good functional recuperation
- that best respects nerve tissue. It should allow one to remove the herniated material without causing

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<th>Figure 1a and 1b. Hansen type I/II herniated intervertebral disks (HIVD). a. A Hansen type I (HIVD I) is a “non contained” hernia: there is complete rupture of the fibrous anulus. The disk nucleus leaks into the vertebral canal and compresses the spinal cord. HIVD I are always associated with contusion of the spinal cord, the extent of which depends on the kinetic energy with which the extrusion occurs. b. A Hansen type II (HIVD II) a “contained” hernia. There is partial rupture of the fibrous anulus and nucleus pulposus bulges into the breach without leaking of diskal material into the vertebral canal. HIVD II are associated with degeneration of the spinal cord, the extent of which depends on the degree and the duration of compression.</th>
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<td>Figure 2. Lateral corpectomy.</td>
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<td>Table 1. Recommended equipment for surgical treatment</td>
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<td>To access the vertebral column</td>
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<td>Apart from a range of retractors needed to push back muscle masses (Gelpi, Gosset, Howmann elevator etc.), the Freer dissector is a very useful instrument for lifting and pushing back paravertebral muscles.</td>
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<td>For the diskectomy</td>
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<td>Small disk forceps or straight or angled mini curettes are useful for removing diskal content.</td>
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<td>To make the bone window to create the opening of the vertebral canal</td>
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<td>This requires a high speed bur (up to 90,000 revolutions) with an irrigation system. This tool allows one to work with low pressure exerted on the bone. Thus, the work is precise and effective. A foot control for the motor is an added safety element.</td>
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<td>The resection of the internal cortical layer</td>
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<td>A specifically adapted instrument is used: Kerrisson rongeur. By tilting the shoe, the bone plate can be removed whilst limiting trauma made to the spinal cord (Figure 3).</td>
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<td>Intracanal extraction of the diskal material</td>
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<td>This can be made with a range of micro-instruments borrowed from dentistry or ophthalmology (tartar hooks, Arruga forceps etc.).</td>
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<td>To control hemorrhage</td>
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<td>Hemorrhaging can sometimes be heavy and requires the use of a bipolar electric cautery and a suction system as well as hemostatic compresses (Surgicel ND) or Horsley wax (Figure 4).</td>
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extra trauma on the nerve. In particular, the surgeon should avoid direct or indirect contact with nervous tissue;

- that best preserves the stabilizing structures of the vertebral column. Destroying them always creates pain and therefore delays functional recuperation and causes a biomechanical imbalance of the vertebral column in the short and medium term;

- that is the least invasive. By focusing on mini-approaches both to access the vertebral column (preservation of the musculature) and to access the disk material (limited canal opening), functional recuperation will be faster;

- that is best adapted to the type of herniated intervertebral disk. Extracting the disk material of a Hansen type II hernia called a “hard hernia” is more difficult and more traumatizing for the spinal cord than extracting a Hansen type I (DHI) herniated intervertebral disk, called a “soft” hernia.

### Cervical vertebral disk surgery

#### Treating Hansen type I cervical herniated intervertebral disks (HIVD I)

Hansen type I cervical herniated intervertebral disks are the source of more or less severe neck pain. They are rarely associated with paralysis. The neurological deficit that is most often seen is paresthesia in one of the front legs. Type I cervical HIVD is generally found in animals over 6 years old. The disk that is most often affected is the one that separates the second from the third cervical vertebra (C2-C3) (Figure 5). HIVD I are always ventral or very slightly lateralized.

Surgery is recommended when medical treatment fails or cervical pain systematically recurs after stopping treatment. The presence of neurological signs (paresthesia in front legs) or a clinical presentation indicating worsening of the condition also justifies an intervention.

The prognosis after intervention is excellent. Recuperation is complete and fast (within 48 hours) in all neck pain animals whether they have a minor nerve deficit or not.
The surgical treatment is a ventral corpectomy centered on the herniated disk.

1. The animal is placed in a dorsal recumbency, the neck is held extended, perfectly aligned with the rest of the body. The head is fixed to the table by adhesive straps and the front legs are fixed extended backwards.

2. The cutaneous incision is centered on the intervertebral area to be operated and is extended to two bodies of vertebrae rostrocaudally. After separating the sterno-hyoidien muscles, the trachea-esophagus block is drawn back on one side and the vascular-nerve “package” (vagus nerve and carotid) on the other. Take note of the recurrent laryngeal nerve associated with the trachea in order to be able to preserve it. This approach allows one to uncover the long muscles of the neck that are removed from the ventral tubercle of the disk space to be operated. This allows one to uncover the ventral surface of the anulus of the disk concerned. It is located caudally using a C6 transverse process and rostrally using a ventral tubercle of the atlas vertebra.

3. The opening of the vertebral canal starts by incision of the ventral side of the anulus using a number 11 blade. The diskectomy is made using disk forceps. The corpectomy (Figure 6) is made using a bur to create a slot centered on the hollowed intervertebral space. The width of the slot should not exceed a third of the width of the body of the vertebra and the length of it, a third of the length of the body of the vertebra and the intervertebral space, otherwise there is a risk of post-operative vertebral instability. Moreover, the axis of the slot should follow the slant of the disk. The opening of the canal is made using a Kerrisson taking care to remain exactly in the median axis otherwise there is a risk of starting serious hemorrhaging of the epidural veins. The extraction of the herniated disk material is made using a foam hook.

4. Closure is made in the classical way, plane by plane.

5. Post-operative care is as normal. For mobile animals recuperation is fast (12 to 24 hours) but activity should be limited to toilet walks for 3 weeks. The dog should be on the leash and a harness should be used instead of a collar.

For bedridden dogs, nursing care is continued until functional recuperation is achieved. Short term corticotherapy can be useful to limit edema and pain.

Lateralized cervical herniated intervertebral disk. In the rare case that the hernia is lateralized or forminal, a hemilaminectomy is required. The approach to the vertebral column is dorsal from the median plane or dorso-lateral. Access to the disk material is possible after facetectomy (Figure 7a) of the area concerned.

Type II herniated intervertebral disk (HIVD II)
Type II HIVD are frequent in the cervical area. Doberman, Labrador and Bernese Mountain dog breeds are most often affected but they also frequently occur in small breeds such as the Yorkshire Terrier. When they are symptomatic they
are the cause of degenerative myelopathy, the clinical signs of which are identical to those described for Wobbler syndrome. The disk between C6 and C7 is most often involved (Figure 8). Surgical treatment is made by corpectomy in the same way as that described for HIVD I except that it is generally associated with intervertebral arthrodesis (Figure 9). The prognosis is reserved.

**Thoraco-lumbar disk surgery**

**Treating type I (TL I HIVD) thoraco-lumbar herniated intervertebral disks**

Thoraco-lumbar herniated intervertebral disks are the most frequent type I hernias. In contrast to the pain associated with cervical hernias, they are associated with serious neurological deficits because they bring about more serious medullary damage that requires quick decompression. Seventy five percent of hernias occur between T11 and L2. The disks T12/T13 and T13/L1 are the most commonly affected (Figure 10) (45% of cases). They can appear from the age of one but are most likely to appear between 3 and 5 years old. Chondrodystrophic breeds (Dachshund, Shi Tzu, Bulldog) are most affected.

The presence of a neurological deficit, even a slight one, means that surgery is recommended. Neurological signs are most commonly a proprioceptive defect of the back legs on a mobile dog (stage 2). Surgery is required because it is a sign of medullary damage that is likely to become worse at any moment. Stage 3 (ambulatory paraplegia) and stage 4 (non ambulatory paraplegia) are conditions that have a good to excellent prognosis after surgery. For cases in which there is loss of sensation (stage 5) (Figure 11), the prognosis is very reserved and is practically a contraindication for surgery. The development time for clinical signs (from a few seconds to a few hours), the degree and the extent of the compression (slight compression or on the other hand major compression at several levels), the pre-operation appearance of the spinal cord (myelomalacy or lack of hematoma) as well as the delay before surgery (from a few hours to over 48 hours) are factors that allow one to adapt the prognosis of stage 5 patients. Statistically, 30 to 50% of animals operated within a period of 48 hours recover ambulatory functions.

**Surgical treatment consists in extracting disk material by foraminopediculectomy (Figure 7b)**

1. The animal is positioned in lateral or ventral recumbency.

2. Cutaneous incision along the median line of the back, then lumbodorsal fascia incision along the spinal area then periosteum elevation of the paravertebral muscles. Removing the inserted tendon on the articular process allows one to visualize the lateral side of the disk anulus. The diskectomy is performed using a number 11 blade.
3. Opening the vertebral canal is made using a bur by foramino-pediculectomy centered on the accessory process that is resected, the articular process being conserved (Figure 12). If the bone window that has been created is too narrow to allow for satisfactory decompression as well as the complete removal of disk material, the articular process is sacrificed. The extraction of disk material is made using a micro-spatula and a suction cannula.

4. Closure is made plane by plane making a continuous suture on the paraspinal muscles subcutaneously and cutaneously.

5. After the operation it is best to manage pain by using a combination of corticosteroids (prednisone 0.5 mg/kg in two doses) and morphine (morphine chlorohydrate: 0.3 mg/kg sc 2 to 3 times/day). Miction should be monitored because urinary retention is frequent. It may be necessary to use alpha 1 antagonists. After a week of rest, physiotherapy should be carried out to promote recovery.

Treating type II herniated intervertebral disks (HIVD II)

Type II HIVD associated degenerative myelopathy that develops over several months. They are not painful. The average age when the first signs appear is 8 years old and the German Shepherd is the most affected breed (Figure 13).

Treating HIVD II is difficult due to the very dense or indeed calcified consistency of the disk material and the vulnerability of the degenerated superjacent spinal cord. Surgical treatment consists in extracting disk material by lateral corpectomy. The principle of the lateral corpectomy is to create a cavity ventral to the spinal cord centered on the intervertebral space into which the herniated disk will collapse (Figure 2). The advantage of this approach is to create wide exposure and complete decompression whilst limiting risks of medullary trauma.

The presence of slight ataxia associated or not with proprioceptive regression should be a reason for carrying out this surgery.

The prognosis after surgical intervention is good for 93% of dogs.
Operation protocol

1. The patient lies in lateral recumbency.

2. The approach path is the same as that described for type I HID.

3. It is not necessary to open the vertebral canal. However, a single pedicle foraminotomy allows the ventral side of the dura mater, the dorsal side of the vertebral canal and the hernia to be exposed which allows medullary decompression to be better controlled.

4. The lateral corpectomy starts by incising the lateral portion of the anulus. The disk is then partially excised with disk forceps. The intervertebral area is enlarged to the adjacent bodies of vertebrae cranial and caudal direction using a bur. Thus, an open cavity is created laterally. The dorsal cortical bone of each vertebra is progressively thinned until it is possible to cave this wall into the cavity using a spatula slid along the ventral side of the dura mater. This spatula should be moved without mobilizing the spinal cord.

5. Post operative care is carried out as described previously. Analgesic medication and rest for 3 weeks is prescribed followed by physiotherapy.

Lumbo-sacral disk surgery

Treating intracanal lumbo-sacral herniated intervertebral disks (LSHIVD)

These are nearly always Hansen type II and do not cause a medullary syndrome but a radicular one often accompanied by pain. Confirmation of involvement of the hernia in the neurological syndrome observed implies, in theory, coherence between the clinical signs (signs of radicular suffering), imaging (disk-root conflict) and the electromyography (modification of the speed of nerve conduction and electromyographic signs of denervation in the areas concerned). The prognosis after surgery is good. These hernias are situated in a median or lateromedian position.

Surgical treatment is based on a classical dorsal approach by laminectomy

1. The dog lies in ventral recumbency, held perfectly straight by adhesive straps. There are no cushions under the stomach to avoid abdominal overpressure likely to worsen bleeding.

2. Cutaneous incision on the median line is made extending from L6 to the first caudals. Incision of the lumbodorsal fascia is made paying attention to the spinous processes. Periosteal elevation of the epiaxial muscles. Sectioning of the spinous processes using Liston forceps.

3. A bone window is made using a bur or bone forceps. It is centered on the lumbo-sacral inter-arc space and extends cranial to the middle of L7 and caudal to space S2-S3. Its medio-lateral limits are defined by articular processes that should be maintained because at this level they play an important mechanical role. The opening of the canal starts by resectioning the interarc ligament. Removal of the internal cortical bone is made using a Kerrisson rongeur. Exploration of the canal allows the