Retrospective Study of Dorsal Laminectomy for Multiple Cervical Intervertebral Disk Disease in Small Dogs

小型犬種における多発性頚部椎間板ヘルニアに対する背側椎弓切除術の回顾的研究

Kosuke HAIII*, Hitoshi MAKINO, Kyohei KANO, Rina TAGAI, Tomoko KANAYAMA and Motoji MOROZUMI

Summary: The medical records of 19 small-breed dogs (≤10 kg) treated with dorsal laminectomy of adjacent vertebrae for multiple cervical intervertebral disk disease between April 2006 and April 2015 were reviewed. After transient postoperative worsening, all dogs regained ambulation at a mean of 8.5 ± 4.72 days after surgery without complications. Recurrence of neck pain was reported approximately 3 months postoperatively in two dogs but was well controlled with conservative management. These findings suggest that dorsal multiple laminectomy is effective for cervical intervertebral disk disease with multiple sites of involvement in small dogs.

Keywords: Dorsal laminectomy, multiple cervical intervertebral disk disease, prognosis

INTRODUCTION

Cervical intervertebral disk disease (CIVDD) in small dogs can involve multiple disk spaces, and it is often difficult to identify the most affected site with diagnostic imaging\(^1,11,12\). Ventral slot decompression at multiple vertebrae is one treatment option in these cases, but this procedure often requires vertebral stabilization to prevent post-surgical cervical instability\(^2,4,7,10,12\). In addition, the size of the slot can be inadequate for manipulation of instruments in small dogs, if slot size is restricted to one-third of the width of the vertebral body, as is generally recommended\(^12\). Creation of a wider slot for better access compromises vertebral stability, increasing the risk of complications\(^4,7,12\). For these reasons, dorsal multiple laminectomy without facetectomy has been our procedure of choice for multiple CIVDD in small dogs. The purpose of this study was to retrospectively evaluate the outcomes and effectiveness of this procedure in client-owned small-breed dogs.

MATERIALS AND METHODS

Animals

Nineteen dogs meeting the following criteria were included in this study: 1) weight of 10 kg or less, 2) moderate or severe CIVDD affecting two or more disk spaces confirmed with magnetic resonance imaging (MRI), 3) dorsal laminectomy of three or more vertebrae performed between April 2006 and April 2015, and...
Hematological and serum biochemical panels, physical examination, neurologic examination, simple cervical radiography, and cervical MRI were performed in all cases. Neurologic examination included postural reactions of the limbs and spinal reflexes. Based on neurologic exam findings, patients were classified as Grade 1 (cervical pain only), Grade 2 (ambulatory but reduced postural reactions in one or more limbs), or Grade 3 (nonambulatory and tetraparetic) before and 1 day after surgery.

MRI was performed at Companion Animal Medical Imaging Center (Camic; Tokyo, Japan). Sagittal, coronal, and transaxial T1- and T2-weighted and T2-FLAIR images were obtained to identify lesions (Fig. 1). Cranial CIVDD was defined as disk disease occurring at C2-C3 and C3-C4; caudal CIVDD was disease present at C4-C5, C5-C6, and C6-C7. Spinal cord compression was quantitatively assessed on transverse T2-weighted images. The percentage of compression was calculated as [(average uncompressed cross-sectional area (CSA) of spinal cord – maximum compressed CSA) / average uncompressed CSA] × 100. Disk protrusion was classified as no herniation, mild, moderate, or severe. Mild indicated that <25% of the vertebral canal was occupied by protruded disk, moderate indicated >25% but <50% protrusion, and severe indicated >50% protrusion.

Laminectomy sites were determined based on compression graded moderate or severe and the possibility of further protrusion.

Surgical procedure
After premedication with glycopyrrolate (Robinul®; AMERICAN REGENT, New York, NY, U.S.A.; 0.01 mg/kg IV), midazolam (Dormicum Injection®; Astellas Pharm, Tokyo; 0.2 mg/kg IV), and morphine hydrochloride (Takeda Pharmaceutical, Osaka, Japan; 0.3 mg/kg IM), anesthesia was induced with propofol (Fuji Pharma, Tokyo; 4 mg/kg IV). The animal was then intubated and anesthesia was maintained with 2.0 to 3.0% isoflurane (ISOFLU®; DS Pharma Animal Health, Osaka).

All surgeries were performed with the Funkquist type B procedure. The animal was placed in sternal recumbency for a standard dorsal approach to the cervical spine. After a dorsal midline incision, the nuchal ligament was retracted laterally to the assistant’s side (the patient’s right side), and the underlying muscles were separated into right and left sides to expose the dorsal laminae. The muscles were retracted laterally with Gelpi retractors to access the laminae. Laminectomy was performed carefully with 1.5-mm-tip rongeurs, approaching from the cranial and caudal spaces of the vertebra of interest (Fig. 2). The yellow ligament was resected with Metzenbaum scissors. Articular processes were preserved. After removal of each lamina, the Gelpi retractors were warmed, and the muscles were moistened with saline and massaged to minimize ischemic damage. After removal of all laminae cranial and caudal to the sites of compression, the exposed cervical spinal cord was covered with subcutaneous fat harvested from the shoulder, and the wound was closed routinely. If compression was present at C2-C3, only C3 laminectomy and C2-C3 yellow liga-ment resection were performed.

All dogs received ampicillin (20 mg/kg SC bid), tranexamic acid (40 mg/kg SC sid), and prednisolone (0.5 mg/kg SC sid) for 3 days after surgery. Prednisolone was gradually tapered over a period of 2 weeks. None of the dogs wore a neck brace for cervical stability postoperatively.

Data Collection and Analysis
Data analyses included breed, age, sex, preoperative neurologic grade, disk spaces affected, sites of laminectomy, early postoperative neurologic grade, days to ambulation after surgery, and recurrence. All data were described as mean ± SD. Sex differences were compared with a chi-squared test. Mean time to ambulation according to age, sites of laminectomy, and preoperative neurologic grade were compared with one-way analysis of variance. Other data were compared with an independent t-test at a significance level of p<0.05.

RESULTS
Data on signalment, sites affected, days to ambulation after surgery, and recurrence are summarized in Table 1. All cases became ambulatory after surgery, and no complications were reported. The time to ambulation ranged from 1 to 20 days post-surgery (mean ± SD, 8.47 ± 4.72 days). Immediate postoperative worsening of neurological status was observed in all cases but one; 18
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Fig. 1. Example of sagittal T2-weighted magnetic resonance image demonstrating multiple intervertebral disk disease. Sagittal and axial images. In this case, protrusion of disk material is seen at four adjacent disk spaces (C3-C4-C5-C6-C7) (arrows). Percentage of compression is 31.8% at C3-C4, 28.8% at C4-C5, 38.8% at C5-C6, and 30.1% at C6-C7.

Fig. 2. Dorsal laminectomy of adjoining vertebrae. (A) Exposure of the dorsal laminae. (B) After removal of the laminae. Note that articular processes are preserved.
cases were Grade 3 on the first day after surgery. Cervical pain (Grade 1) recurred in two cases nearly 3 months post-surgery after ambulatory improvements were seen. Both of these cases were managed without surgery.

Treated dogs included five Maltese, four miniature pinschers, three Yorkshire terriers, two Pekingese, two Chihuahuas, and one each of Pomeranian, papillon, and miniature dachshund. Only three of the 19 dogs (15.7%) were chondrodystrophic breeds (one miniature dachshund and two Pekingese). No significant sex predilection was found [10 males (53%) vs. nine females (47%)], although the two cases of recurrence were both female.

Patient age ranged from 6 to 13 years, with a mean of 9.5 years. The mean time to ambulation according to age was 15.6 ± 5.13 days (range, 10–20 days) in 6-year-old dogs, 5.75 ± 4.03 days (range, 1–10 days) in 9-year-olds, 6.87 ± 2.47 days (range, 4–10 days) in 10-year-olds, 11.5 ± 4.95 days (range, 8–15 days) in 11-year-olds, 6 days in the 12-year-old and 7 days in the 13-year-old. The time to ambulation was not significantly different among these age groups. The two recurrence cases were both 10 years old.

Disk protrusion was observed from C2-C3 to C6-C7 on MRI; CIVDD with cranial involvement alone was not observed in any of the cases. All cases had caudal CIVDD with or without cranial CIVDD. Cranial involvement was observed in 58% of dogs (11/19). There was no significant difference in time to ambulation between dogs with cranial involvement versus those without. The two cases with recurrence both had cranial lesions (C3-C4-C5 and C3-C4-C5-C6).

The number of laminae removed was three in 16% of cases (3/19), four in 53% (10/19), and five in 31% (6/19). The time to ambulation was not significantly different among these groups. Of the two cases with recurrence, one had laminectomy of three vertebrae and one had laminectomy of four vertebrae.

Preoperatively, there were no Grade 1 cases; 47% (9/19) were Grade 2 and 53% (10/19) were Grade 3. Both recurrence cases were Grade 2. The mean time to

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Table 1. Signalment, preoperative findings and postoperative outcome

| Breed               | Sex    | Age  (yrs) | Compression site† | Laminectomy site† | Neurologic Exam Grade Pre-op | Day 1 Post-op | Day to Ambulation (day) | Recurrence |
|---------------------|--------|------------|-------------------|-------------------|-------------------------------|---------------|-------------------------|------------|
| Maltese             | Female | 10         | C3-C4-C5          | C3-C4-C5          | 2                             | 3             | 7                       | o          |
| Pekingese*          | Male   | 9          | C4-C5-C6-C7       | C4-C5-C6-C7       | 3                             | 3             | 4                       |            |
| Pomeranian          | Male   | 9          | C3-C4-C5          | C3-C4-C5          | 3                             | 3             | 8                       |            |
| Yorkshire Terrier   | Female | 11         | C2-C3-C4-C5       | C2-C3-C4-C5       | 3                             | 3             | 8                       |            |
| Miniature Dachshund*| Male   | 12         | C3-C4-C6-C7       | C3-C4-C6-C7       | 3                             | 3             | 6                       |            |
| Miniature Pinscher  | Male   | 10         | C4-C5-C6-C7       | C4-C5-C6-C7       | 3                             | 3             | 5                       |            |
| Maltese             | Female | 10         | C1-C2-C3-C4-C6    | C1-C2-C3-C4-C6    | 2                             | 3             | 4                       | o          |
| Chihuahua           | Male   | 6          | C2-C3-C4-C5-C6-C7 | C2-C3-C4-C5-C6-C7 | 3                             | 3             | 10                      |            |
| Maltese             | Female | 10         | C4-C5-C6-C7       | C4-C5-C6-C7       | 3                             | 3             | 10                      |            |
| Miniature Pinscher  | Male   | 6          | C4-C5-C6-C7       | C4-C5-C6-C7       | 3                             | 3             | 17                      |            |
| Pekingese*          | Male   | 6          | C4-C5-C6-C7       | C4-C5-C6-C7       | 3                             | 3             | 17                      |            |
| Miniature Pinscher  | Female | 10         | C1-C2-C3-C4-C6    | C1-C2-C3-C4-C6    | 3                             | 3             | 9                       |            |
| Papillon            | Male   | 9          | C2-C3-C4-C5-C6-C7 | C2-C3-C4-C5-C6-C7 | 2                             | 1             | 1                       |            |
| Yorkshire Terrier   | Male   | 10         | C3-C4-C5-C6-C7    | C3-C4-C5-C6-C7    | 2                             | 3             | 5                       |            |
| Chihuahua           | Male   | 10         | C1-C2-C3-C4-C6-C7 | C1-C2-C3-C4-C6-C7 | 2                             | 3             | 5                       |            |
| Yorkshire Terrier   | Male   | 11         | C2-C3-C4-C5-C6-C7 | C2-C3-C4-C5-C6-C7 | 3                             | 3             | 15                      |            |
| Maltese             | Female | 10         | C1-C2-C3-C4-C6-C7 | C1-C2-C3-C4-C6-C7 | 2                             | 3             | 10                      |            |
| Maltese             | Female | 13         | C2-C3-C4-C5-C6-C7 | C2-C3-C4-C5-C6-C7 | 2                             | 3             | 7                       |            |

* Chondrodystrophic breeds, † Cervical (C) disk numbers.
ambulation was 7.6 ± 5.43 days (range, 1–20 days) for Grade 2 cases and 9.2 ± 4.13 days (range, 4–7 days) for Grade 3 cases. There was no significant difference in time to ambulation between these grades.

**DISCUSSION**

The present study retrospectively evaluated the effectiveness of dorsal laminectomy for multiple CIVDD in small-breed dogs. The study population included a small percentage of chondrodystrophic breeds (15.7%) and had a relatively high mean age of onset (9.5 years); caudal cervical spinal compression was observed in all cases. These findings indicate that in this small-breed population multiple CIVDD was likely Hansen type II disk protrusion, which involves progressive thickening of the dorsal annulus fibrosus in association with cervical vertebral instability similar to the caudal cervical spondylomyelopathy typically seen in large-breed dogs

All cases in the present study regained ambulation after dorsal laminectomy. In a study by Gill et al., the success rate of dorsal laminectomy was also 100% for solitary CIVDD. In our study, dorsal laminectomy was performed in multiple adjacent vertebrae for CIVDD affecting two or more disk spaces; the outcome was still favorable without any major complications. Neck pain recurred in two dogs (10%). These patients had received laminectomies of 3 or 4 vertebrae. It is possible that protrusion occurred at adjacent disk spaces; however, the exact causes of recurrence were undetermined because myelography or MRI was not performed after recurrence. In multiple CIVDD, therefore, careful preoperative evaluation is necessary to determine how many vertebral laminae should be removed.

There was no association between time to ambulation and breed, preoperative neurological status, site of protrusion, or number of laminae removed. Not unexpectedly, 94.7% (18/19) of the patients experienced transient neurological worsening immediately after surgery. This worsening likely occurred because a dorsal approach is more invasive than a ventral approach and Gelpi retraction can cause temporary muscle ischemia. However, all patients recovered in a mean ± SD of 8.5 ± 4.72 days, and 85% (16/19) were walking within 10 days. In a study by De Risio et al., dorsal laminectomy was successful in improving the postoperative neurological status in 19 of 20 dogs. The percentage of dogs with neurological worsening after dorsal laminectomy in that study was 70%. However, the morbidity associated with dorsal laminectomy is typically transient; the reported cause is related to the extensive muscle dissection necessary with the dorsal approach, which produces significant tissue trauma and postoperative edema. Taking all of these findings together, multiple dorsal laminectomy was an effective surgical technique for multiple CIVDD in the small-breed population in this study. The technique is also advantageous in that it does not require a cumbersome vertebral stabilization procedure and should be considered as a promising addition to other frequently reported surgical techniques such as ventral slot decompression and hemilaminectomy. Still, technique selection should be predicated on thorough evaluation of the patient’s status, diagnostic imaging findings, and the advantages and disadvantages of each technique.

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