Clinical effects of computed tomography–guided lumbosacral facet joint, transforaminal epidural, and translaminar epidural injections of methylprednisolone acetate in healthy dogs

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OBJECTIVE
To determine clinical effects of CT-guided lumbosacral facet joint, transforaminal epidural, and translaminar epidural injections of methylprednisolone acetate in healthy dogs.

ANIMALS
15 healthy Beagles.

PROCEDURES
Dogs were randomly assigned to 3 groups (5 dogs/group) and received a single CT-guided lumbosacral facet joint, transforaminal epidural, or translaminar epidural injection of methylprednisolone acetate (0.1 mg/kg). Contrast medium was injected prior to injection of methylprednisolone to verify needle placement. Neurologic examinations were performed 1, 3, 7, and 10 days after the injection. In dogs with neurologic abnormalities, a final neurologic examination was performed 24 days after the procedure.

RESULTS
Methylprednisolone injections were successfully performed in 14 of the 15 dogs. In 1 dog, vascular puncture occurred, and the methylprednisolone injection was not performed. No major or minor complications were identified during or immediately after the procedure, other than mild transient hyperthermia. During follow-up neurologic examinations, no motor, sensory, or postural deficits were identified, other than mild alterations in the patellar, withdrawal, cranial tibial, and perineal reflexes in some dogs. Overall, altered reflexes were observed in 11 of the 14 dogs, during 27 of 65 neurologic examinations.

CONCLUSIONS AND CLINICAL RELEVANCE
Results suggested that CT-guided lumbosacral facet joint, transforaminal epidural, and translaminar epidural injections of methylprednisolone acetate were associated with few complications in healthy dogs. However, the number of dogs evaluated was small, and additional studies are needed to assess clinical efficacy and safety of these procedures. (Am J Vet Res 2016;77:1132–1139)

In dogs, degenerative lumbosacral stenosis is considered the most common cause of cauda equina syndrome. This condition is characterized by intervertebral disk degeneration and herniation, compensatory new bone production, proliferation of surrounding soft tissues (eg, the interarcuate ligament), epidural fibrosis, and degenerative facet joint disease.1 These modifications result in displacement or compression of the sixth and seventh lumbar, first to third sacral, and first to fifth coccygeal spinal nerve roots, with consequent back pain and neurologic dysfunction.1–3

Oral administration of NSAIDs, a reduction in body weight, changes in exercise patterns, and decompressive surgery are the suggested treatments for dogs with degenerative lumbosacral stenosis.1–4 However, nonsurgical treatments may not always be effective, and some owners may be reluctant to pursue surgery. Therefore, additional treatment options could be helpful.

In human medicine, corticosteroid injections in the epidural or facet joint spaces are commonly performed for patients with lower back pain and radiculopathy.3–7 Although the exact mechanism of action is unclear, suppression of prostaglandin synthesis, decreased formation of inflammatory leukotrienes, decreased capillary wall permeability and subsequent decreased edema formation, osmotic dilution and washout of inflammatory cytokines, and local...
enhancement of blood flow to ischemic nerve roots have been proposed. A major complication rate (ie, complications requiring an emergency room visit or hospitalization) of 0.07% has been described, whereas the minor complication rate reportedly ranges from 9.6% to 15.6%. Complications can be related to the procedure itself or to the compound that is injected. Procedure-related complications include infections, such as epidural abscesses and meningitis, and inadvertent subarachnoid or intravascular injection resulting in epidural or subdural hematoma, arachnoiditis, seizures, or spinal cord injury. Allergic reactions and systemic corticosteroid effects such as hypercorticism and corticosteroid-induced myopathy have been reported as drug-related complications. Inaccurate needle placement occurs in 25% to 30% of blind injections and the loss-of-resistance test is an inaccurate tool to verify correct placement of the needle in the epidural space. Therefore, to increase the safety and efficacy of epidural and facet joint corticosteroid injections, a CT-guided approach is preferred because it allows safe needle progression and precise positioning at the target. Injection of nonionic contrast medium before injection of corticosteroids is recommended to confirm correct positioning of the needle and avoid inadvertent dural or intravascular puncture.

Epidural injection of corticosteroids has been suggested as an alternative treatment for degenerative lumbosacral stenosis in dogs. However, in the only clinical study that, to our knowledge, has been performed, clinical and long-term effects were evaluated by the owners, and no neurologic examination results were reported. Moreover, corticosteroid injections were performed under fluoroscopy, not with CT guidance.

More recently, we evaluated the technical feasibility of performing CT-guided lumbosacral facet joint, transforaminal epidural, and translaminar epidural injections of methylprednisolone acetate in dogs and found that these injections were feasible. However, only cadavers were used in that study, and clinical effects were not evaluated. Therefore, the purposes of the study reported here were to determine the clinical effects of CT-guided lumbosacral facet joint, transforaminal epidural, and translaminar epidural injections of methylprednisolone acetate in healthy dogs and describe procedure-related complications. Our hypothesis was that facet joint and epidural injections of methylprednisolone acetate would be associated with a low rate of procedure-related complications.

Material and Methods

Fifteen adult Beagles were used in the study, with the approval of the University of Liege Animal Care and Use Committee. Dogs were considered healthy and free from orthopedic and neurologic deficits on the basis of history and results of general physical and neurologic examinations performed 24 hours before the start of the study.

Dogs were randomly assigned to 3 groups with 5 dogs/group. Dogs in the first group (3 sexually intact males and 2 sexually intact females; all 8 years old and weighing between 15 and 16 kg) received a single CT-guided injection of methylprednisolone acetate (1 mg/kg) in the left or right facet joint between the caudal articular process of L7 and the cranial articular process of S1. Dogs in the second group (1 sexually intact male and 4 sexually intact females ranging from 2 to 4 years old and weighing between 11 and 17 kg) received a single left or right CT-guided lumbosacral transforaminal epidural injection of methylprednisolone acetate (1 mg/kg). Dogs in the third group (1 sexually intact male and 4 sexually intact females ranging from 2 to 8 years old and weighing between 11 and 15 kg) received a single CT-guided lumbosacral transforaminal epidural injection of methylprednisolone acetate (1 mg/kg). For the facet joint and transforaminal injections, the left or right side was randomly chosen.

For all injections, dogs were premedicated with medetomidine (20 µg/kg, IV) and, 5 minutes later, anesthetized with propofol (IV, to effect). Auffed endotracheal tube was placed, and dogs were connected to a circle breathing system. Anesthesia was maintained with isoflurane in oxygen. During the procedure, heart rate, respiratory rate, and oxygen saturation of hemoglobin were monitored continuously; rectal temperature was recorded every 15 minutes. After the procedure, the dogs received a single injection of atipamezole (100 µg/kg, IM).

Once anesthetized, dogs were positioned in sternal recumbency with the hind limbs placed cranially, and CT of the lumbosacral region (helical acquisition mode; slice thickness, 1 mm; pitch, 0.8 mm; 120 to 140 kV; and 200 to 300 mA) was performed to identify any bony abnormalities or dystrophic mineralization that could be misdiagnosed as contrast medium. All injections were performed by a single individual (APL) under CT guidance, as described. In brief, for the facet joint injections, a 22-gauge, 70- to 90-mm-long spinal needle was directed toward the most dorsal aspect of the lumbosacral facet joint, identified on transverse section as the hypoattenuating space between the caudal articular process of L7 and the cranial articular process of S1 (Figure 1). For the transforaminal epidural injections, a spinal needle was inserted in a dorsolateral-to-ventromedial direction toward the dorsal aspect of the lumbosacral intervertebral foramen, identified on transverse section (Figure 2). The angle of the needle was varied on the basis of angle of the lumbosacral intervertebral foramen, which differed among dogs. For the translaminar epidural injections, a spinal needle was inserted in a dorsoventral direction toward the space between the lamina of L7 and the lamina of S1, identified on transverse section (Figure 3). For all injections, once the target was identified, short-ranging CT scans (120 kv; 50 mAs; and slice thickness, 0.75
mm) performed with routine biopsy software were used to follow the needle insertion and perform the CT-guided injections.

Iohexol (0.15 mL for facet joint injections and 2 mL for transforaminal and translaminar epidural injections) was used to verify correct positioning of the needle. Immediately after injection of iohexol, a second CT examination was performed, and contrast medium spread was evaluated. For facet joint injections, needle positioning was considered correct if contrast medium was present within the articular space (Figure 4); positioning was also considered acceptable if periarticular contrast medium was seen. For the transforaminal (Figure 5) and translaminar (Figure 6) injections, needle positioning was considered correct if contrast medium was present within the epidural space. A small amount of contrast medium in the subarachnoid space was considered acceptable (Figure 7). However, if no contrast medium was visualized, vascular puncture with contrast medium migration was assumed (Figure 8) and the needle was repositioned. If correct positioning of the needle within the epidural space could not be obtained after 3 attempts, the procedure was abandoned, and methylprednisolone was not injected. For all injections, once correct needle positioning was verified, methylprednisolone was injected. The calculated dose of methylprednisolone was mixed with saline (0.9% NaCl) solution to create a final volume of 0.5 mL for facet joint injections or 5 mL for transforaminal and translaminar injections.

For all dogs, physical and neurologic examinations were performed 1, 3, 7, and 10 days after the procedure. Examinations included measurement of rectal temperature; evaluation for signs of paresis or paralysis (ie, partial or complete loss of voluntary movement manifested as decreased or absent range of motion), signs of pain during palpation of the caudal lumbar region or hyperextension of the tail, proprioceptive deficits, hind limb lameness, and urinary incontinence; and evaluation of the patellar, cranial tibial, withdrawal, and perineal reflexes. All examinations were performed by a single individual (MG) who was aware of the aim of the study but was unaware of the specific type or side of injection for each dog. All abnormalities and neurologic deficits were evaluated and recorded. Each reflex was evaluated at least 3 times before being considered abnormal. For dogs with neurologic abnormalities, an additional examination evaluating only these abnormalities was performed 24 days after the procedure. No other clinical examinations were performed, but regular information concerning the clinical status of the dogs was obtained by contacting the individual in charge of their care.

**Results**

**Facet joint injections**

All 5 dogs that received a facet joint injection had some degree of lumbosacral spondylosis, with 1 also...
having mild lumbosacral disk protrusion. None of the 5 had degenerative joint disease involving the lumbosacral facet joints.

Unilateral lumbosacral facet joint injections were performed in all 5 dogs (right side, 3 dogs; left side, 2 dogs). After injection of iohexol, CT confirmed correct positioning of the needle in 3 of the 5 dogs. In 2 of these 3 dogs, periarticular contrast medium was identified in addition to intraarticular contrast medium. In the remaining 2 dogs, contrast medium was exclusively periarticular.

During the procedure, no increases in respiratory or heart rate and no alterations in oxygen saturation of hemoglobin or rectal temperature were reported. No major complications requiring hospitalization occurred. However, mild clinical abnormalities were observed in 4 of the 5 dogs, during 7 of the 20 clinical examinations. None of the dogs had hyperthermia (rectal temperature > 39.4°C), signs of pain during palpation of the caudal lumbar region or tail hyperextension, hind limb lameness, proprioceptive deficits, or urinary incontinence. The patellar reflex was normal in all 5 dogs on day 1, increased in 1 dog on day 3, increased in 2 dogs on day 7, and increased in 2 dogs on day 10. The cranial tibial reflex was normal in all 5 dogs on day 1, increased in 1 dog on day 3, increased in 2 dogs on day 7, and increased in 2 dogs on day 10. The withdrawal reflex was normal in all 5 dogs on day 1, increased in 1 dog on day 3, increased in 2 dogs on day 7, and increased in 2 dogs on day 10. The perineal reflex was normal in all 5 dogs on days 1 and day 3, decreased in 2 dogs on day 7, and decreased in 1 dog on day 10. When reflexes were reassessed 24 days after the procedure in 4 dogs, no changes were noticed, compared with results for the previous examination in 3 of the 4 dogs. In the remaining dog, patellar and cranial tibial reflexes were considered normal but the withdrawal reflex was decreased, even though it had previously been increased.

At the time of final follow-up approximately 5 months after the procedure, none of the 5 dogs had any relevant clinical abnormalities.

**Transforaminal epidural injections**

One of the 5 dogs in the transforaminal epidural injection group had mild lumbosacral disk protrusion, another had mild lumbosacral vertebral spondylosis, and a third had a mild decrease in the intervertebral space between L5 and L6. Unilateral transforaminal epidural injections were performed in 4 of the 5 dogs.
The presence of contrast medium in the epidural space confirmed correct positioning of the needle in all 4 dogs, with minimal subarachnoid contrast medium in 1 of the 4. In the remaining dog, attempts were made to perform a transforaminal injection from both the left and right side, but vertebral venous puncture occurred. Therefore, corticosteroid injection was not performed.

Nevertheless, this dog underwent regular clinical examinations; no complications were identified.

During the procedure, no increases in respiratory or heart rate and no alterations in oxygen saturation of hemoglobin or rectal temperature were reported. No major complications requiring hospitalization occurred. However, mild clinical abnormalities were noticed in 3 of the 4 dogs in which the injection was performed, during 5 of the 16 clinical examinations. None of the dogs had signs of pain during palpation of the caudal lumbar region or tail hyperextension, hind limb lameness, proprioceptive deficits, or urinary incontinence. Hyperthermia was detected in 1 dog on days 3 and 7 (39.6°C and 39.7°C, respectively) and in another dog on day 7. For both of these dogs, rectal temperature was within reference limits at the other examination times. The patellar, cranial tibial, and withdrawal reflexes were normal in all 4 dogs on days 1, 3, and 7, but were mildly increased in 1 of the 4 on day 10. The perineal reflex was normal in all 4 dogs on day 1, decreased in 1 dog on day 3, decreased in 2 dogs on day 7, and decreased in 1 dog on day 10. When reflexes were reassessed 24 days after the procedure in 3 dogs, the perineal reflex was still decreased in 2 dogs. In one of these dogs, the perineal reflex was decreased on days 3, 7, 10, and 24. In the other, the perineal reflex was normal on days 1 and 3, decreased on day 7, normal on day 10, and decreased on day 24. The patellar reflex was bilaterally increased in 1 dog in which it had been unilaterally increased during the previous examination. However, in this dog, the cranial tibial and withdrawal reflexes, which were unilaterally increased during the previous examination, were normal on day 24.

At the time of final follow-up approximately 5 months after the procedure, none of the 5 dogs had any relevant clinical abnormalities.

Translaminar epidural injections

Two of the 5 dogs in the translaminar epidural injection group had mild lumbosacral vertebral spondylosis, and 1 had mild disk protrusion. A translaminar epidural injection was performed in all 5 dogs. After injection of iohexol, CT confirmed correct positioning of the needle in the epidural space. In 2 of the 5 dogs, a minimal amount of contrast medium was also seen in the subarachnoid space.

During the procedure, no increases in respiratory or heart rate and no alterations in oxygen saturation of hemoglobin or rectal temperature were recorded. No major complications requiring hospitalization occurred. However, mild clinical abnormalities were reported in 4 of the 5 dogs, during 6 of the 20 clinical examinations. One dog had mild hyperthermia on day 10, but none of the dogs had signs of pain during palpation of the caudal lumbar region or tail hyperextension, hind limb lameness, proprioceptive deficits, or urinary incontinence. The patellar, cranial tibial, and withdrawal reflexes were normal in all 5 dogs on days 1 and 3 and were unilaterally decreased in
1 dog on both day 7 and day 10. The perineal reflex was normal in all 5 dogs on days 1 and 3 but was decreased in 2 dogs on day 7 and in 3 dogs on day 10. When reflexes were reassessed 24 days after the procedure in 3 dogs, no changes were noticed, compared with results for the previous examinations.

At the time of final follow-up approximately 5 months after the procedure, none of the 5 dogs had any relevant clinical abnormalities.

Discussion

Results of the present study suggested that CT-guided lumbosacral facet joint, transforaminal epidural, and translaminar epidural injections of methylprednisolone acetate were associated with few complications in healthy dogs. No major complications were identified in any of the dogs, and minor complications consisted mainly of alterations to the patellar, withdrawal, cranial tibial, and perineal reflexes that were not considered clinically important. Importantly, however, the number of dogs evaluated was small. Therefore, additional studies are needed to assess clinical efficacy and safety of these procedures.

In human medicine, because of the high rate of erroneous needle placement associated with blind epidural injection techniques, many imaging techniques to guide needle placement have been developed. Among these, CT guidance is considered the most accurate. Nevertheless, subarachnoid and vertebral venous puncture are still possible complications. The former is more commonly associated with the translaminar approach, whereas the latter is more commonly associated with the transforaminal approach. Therefore, we decided to evaluate both approaches in the present study. Note that in people, the translaminar approach is usually preferred to treat bilateral pain because there is an increased likelihood of reaching adjacent spinal levels with a single injection. On the other hand, the transforaminal approach is more specific and is useful in patients with lateralized signs. It is associated with a lower risk of inadvertent dural puncture but with an increased risk of vascular puncture. In veterinary medicine, subarachnoid puncture was also reported in a study involving assessment of ultrasound-guided epidural injection. This is in agreement with results of the present study, in that we identified mild subarachnoid opacification following iohexol injection in 1 of the 4 dogs in the transforaminal injection group and 2 of the 5 dogs in the translaminar injection group. However, in the present study, vertebral venous puncture occurred on both sides in 1 dog in the transforaminal injection group. We decided not to perform the corticosteroid injection in this dog when vascular puncture was identified. Computed tomography-fluoroscopy could potentially have been used to guide needle placement more precisely, by allowing dynamic visualization of the needle path and contrast medium spread. However, this technique was not available in our facility at the time of the study. Nevertheless, the lack of contrast medium at the injection site in this dog illustrated the utility of contrast medium injection before injection of corticosteroid. In human medicine, intravascular injection of corticosteroids is considered harmful, especially when the arterial system is involved, because of potential embolic phenomena related to the particulate nature of injected corticosteroids, potentially resulting in stroke, a seizure, or permanent paralysis.

In the present study, we elected to perform the corticosteroid injection even if contrast medium was seen within the subarachnoid space. Given the minimal amount of contrast medium in the subarachnoid space in these dogs, we considered it likely that tearing of the dura mater had occurred, rather than true intrathecal positioning of the needle. However, in instances of true intrathecal positioning of the needle, methylprednisolone injection should be avoided because of possible complications such as corticosteroid-induced arachnoiditis.

In many human medical centers, the preferred method for performing facet joint injections is CT guidance, which reportedly is associated with a 94% technical success rate. However, precise intra-articular injection does not seem to be imperative because equivalent results have been described with periarticular injections, and periarticular injections are recommended when intra-articular injection proves difficult. Therefore, for dogs in the facet joint injection group in the present study, we performed corticosteroid injections even when CT revealed periarticular contrast medium.

No major complications occurred in any of the dogs in the present study, although altered reflexes and hyperthermia were identified in all groups. Hyperthermia is defined as any increase in body temperature above the generally accepted upper reference limit, with a threshold of 39.2°C having been suggested. However, the reference range is variable in dogs and may be influenced by many factors. In the present study, we considered dogs to be hyperthermic when rectal temperature was > 39.4°C. Some dogs had a temperature slightly above this threshold without any other clinical abnormalities. During clinical examinations, these dogs tended to behave in a nervous manner, and in all instances, their temperature was within reference limits when assessed at a different time during the same day once the dog was at rest. Therefore, we postulate that the temporary increases in rectal temperatures in these dogs were more likely environment or behavior related, rather than secondary to true disease.

Similarly, in the present study, some alterations in the patellar, cranial tibial, withdrawal, and perineal reflexes were noticed without concomitant motor, sensory, or postural deficits. Some of these alterations showed a fluctuating nature. For instance, in 1 dog, the perineal reflex was decreased on day 7, normal on day 10, and decreased again on day 24. In another
dog, the withdrawal reflex was decreased on day 7, normal on day 10, and increased on day 24.

The patellar, cranial tibial, withdrawal, and perineal reflexes assess neurologic integrity from the fourth lumbar spinal cord segment to the third sacral spinal cord segment. Decreased reflexes may be caused by lesions affecting the sensory or motor component of the reflex arc, whereas increased reflexes are usually caused by lesions in the upper motor neuron pathways cranial to the spinal segment involved in the reflex. However, the absence of motor, sensory, or postural deficits in the dogs of the present study; the subjective nature of reflex assessment; the fluctuating nature of some of these reflexes; and the fact that abnormal reflexes were noticed even in some dogs in the facet joint injection group suggested that these abnormalities were likely of little clinical importance. In human medicine, paraspinal abscesses and arthritis are sporadically reported as complications following facet joint injections. Infectious spread into the epidural space and subsequent meningitis has also been rarely described, with an incidence of < 1%. In the present study, it is difficult to believe that dogs with abnormal patellar, withdrawal, cranial tibial, or perineal reflexes had meningitis in the absence of any other clinical signs or without clinical deterioration despite the absence of treatment. Therefore, we postulate that reflex abnormalities that were identified were most likely behavior related, because altered muscle stretch reflexes have been described in excited and anxious patients. Unfortunately, without MRI or histologic examination, we cannot rule out hematoma formation as a cause of the reflex abnormalities that were seen. However, if a hematoma had occurred, we would have expected abnormalities to be detected immediately after the procedure, and not at a later date as occurred in some of the dogs in the present study.

Other limitations of the present study include the absence of a control group that did not receive corticosteroid injections, the small number of dogs used, and the fact that only a single corticosteroid injection was given. Importantly, in human medicine, data are lacking regarding the optimal number of injections, although multiple injections are often suggested if pain is not completely relieved after the first epidural corticosteroid injection. Physical and neurologic examinations were not performed in the present study to evaluate dogs for long-term complications; however, 5 months after the procedure, none of the dogs reportedly had any clinically relevant abnormalities. In human medicine, transient worsening of symptoms or emergence of new neurologic signs > 24 hours after the injection occurred in 4% of patients, with a median duration of 3 days and range of 1 to 20 days. In most dogs in the present study, the last examination was performed 24 days after the procedure. Thus, we considered the examination protocol sufficient to detect any infectious disease or abscess formation, which are among the most commonly reported complications in human medicine.

In conclusion, results of the present study should be interpreted as preliminary. However, they indicated that in dogs undergoing lumbosacral facet joint, transforaminal epidural, or translaminar epidural injections, CT with contrast medium injection can be used to verify correct positioning of the needle and avoid injections into the vascular system. Further, our findings indicated that minor neurologic abnormalities can be seen after injection of methylprednisolone in the epidural or facet joint space. However, these abnormalities were not considered clinically relevant, suggesting that these techniques could potentially be used in clinical trials.

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### Footnotes

a. Modern long acting (40 mg/mL), Zoetis Belgium, Louvain-la-Neuve, Belgium.

b. Somatom Sensation 16-slice, Siemens, Erlangen, Germany.

c. Spinal needle, Terumo Co Ltd, Tokyo, Japan.

d. Somatom Sensation biopsy software, Siemens, Erlangen, Germany.

e. Omnipaque (300 mg I/mL), GE Healthcare, Diegem, Belgium.

### References


