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Retrospective study of acupuncture treatment for canine thoracolumbar intervertebral disc herniation

Qianyu Jia^{1,2†}, Yu Wang^{3†}, Haidong Pang^{3†}, Kai Fan^{1,2}, Huisheng Xie^{4*} and Jiahao Lin^{1,2*}

Abstract

Thoracolumbar intervertebral disk herniation (TL-IVDH) is a common neurological disorder in dogs, which often affects the life quality of patients and their caregivers. Acupuncture is increasingly accepted by veterinarians and animal owners, and has been used in the treatment of neurologic disorders. This study aims to evaluate the effects of acupuncture treatment for canine TL-IVDH. Clinical cases from 2016 to 2021 were collected. According to the inclusion and exclusion criteria, 94 TL-IVDH cases that received acupuncture treatment were selected. Clinical classification and efficacy criteria were formulated based on the Frankel Score. For each case, clinical presentation, improvement, recovery and recurrence were recorded. Male dogs with TL-IVDH accounted for 64% of all cases. The average age was 7.49 years old, the predominant breed was poodle, and the incidence site was concentrated from T11 to L1. The overall recovery rate after receiving acupuncture treatment was 79.78%, which was comparable when considering only cases with grade 2, 3, or 4 spinal cord lesions (83.33%~85.19%). In conclusion, canine with grade 2, 3, and 4 spinal cord lesions due to TL-IVDH receiving acupuncture had a high recovery rate, suggesting acupuncture could be a viable treatment options for canine with TL-IVDH.

Keywords Dog, Thoracolumbar intervertebral disk herniation, Acupuncture, Review

Introduction

Thoracolumbar intervertebral disk herniation (TL-IVDH) is a common neurological disorder in dogs [1, 2]. It often leads to paraplegia, urination disorders and other clinical

symptoms, affecting the life quality of both the animals and their caregivers.

Treatment options for canine with TL-IVDH include surgery and medical management [3]. Outcomes reported in previous studies recommended surgery as the primary treatment [4, 5]. However, surgery mainly alleviates mechanical injury, and has little effect on the recovery of neuronal functions [6]. Furthermore, the success rate of surgery is greatly reduced in cases with the absence of deep pain for more than 48 h [3]. Medical management, often referred to as conservative treatment, typically relies on using steroid drugs, which often result in adverse effects, such as gastrointestinal complications [7]. In addition, the recurrence rate in patients receiving conservative treatment is high [8].

Acupuncture is a major branch of Traditional Chinese Veterinary Medicine (TCVM). First the etiology and

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pathology of the disease is determined through pattern differentiation. Needles are then inserted into acupuncture points which are chosen based on the pattern differentiation. With advancing research on its treatment mechanisms, acupuncture is increasingly accepted by veterinarians and animal owners, and has been used in the treatment of many neurologic disorders [9].

Several retrospective and prospective studies have compared the effects of different treatments for TL-IVDH, including acupuncture [2–5, 7]. However, most of the studies used a single invariable acupuncture prescription that did not conform with the principles of TCVM pattern differentiation and subsequent adjustments to the acupuncture treatments.

The objective of this retrospective study is to investigate the epidemiological characteristics of canine TL-IVDH, and the effect and relevant factors of the acupuncture treatment for canine TL-IVDH. The study included TL-IVDH canine cases in an animal hospital over five years. It was found that veterinarians would adjust the selection

of acupoints according to different symptoms during treatment, which is the main difference compared to other studies. It is hoped that the reporting of clinical cases receiving acupuncture with methods more in line with the theory of TCVM, the results from this study can provide additional references for the application of acupuncture in the treatment of TL-IVDH in dogs.

Results

Basic information

The cases were collected from the Veterinary Teaching Hospital of China Agricultural University from 2016 to 2021. A total of 21 dog breeds were involved in the study, among which 24 cases (25.5%) were poodles. The mean body weight was 10.0 kg (shown in Table 1). The cases included 61 male and 33 female dogs. The age of dogs ranged from 3 months to 19 years, and the mean age was 7.49 years. More dogs were between 3 and 6 years than any other age range (shown in Fig. 1). Specifically, 4 and

Table 1 Breed and body weight of cases

Breed	Number	Mean B.W ± SEM(kg)	Breed	Number	Mean B.W ± SEM(kg)
Chihuahua	4	2.31 ± 0.50	French bulldog	7	10.43 ± 0.63
Maltese	1	3.32	Mixed	13	11.97 ± 1.44
Miniature Pinscher	2	3.60 ± 0.00	Pug	1	12.50
Yorkshire terrier	2	3.60 ± 0.00	Cocker spaniel	2	12.99 ± 6.01
Poodle	24	5.59 ± 0.52	Japanese spitz	1	13.50
Pomeranian	1	7.00	Beagle	1	16.00
Pekingese	6	7.27 ± 0.52	Corgi	6	16.40 ± 0.72
Bichon Frise	7	7.35 ± 1.03	Samoyed	2	20.00 ± 4.00
Schnauzer	7	7.60 ± 0.42	German shepherd	3	30.00 ± 0.00
Japanese chin	1	7.60	Great Pyrenees	1	60.00
Dachshunds	2	8.15 ± 1.85			

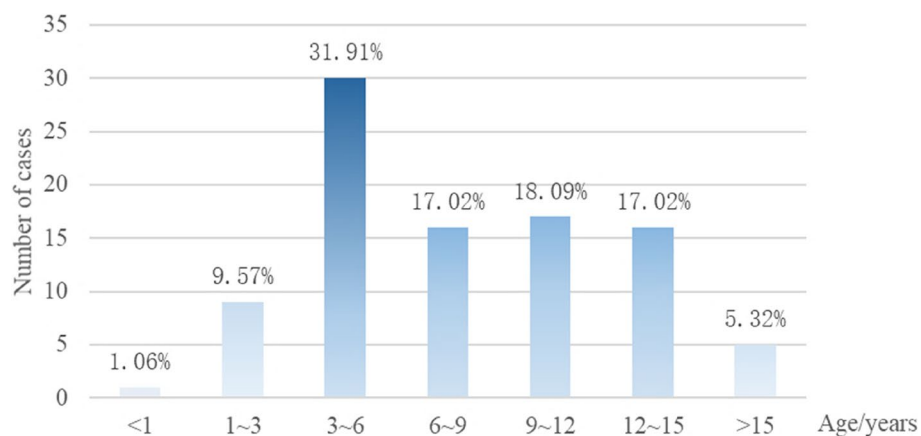


Fig. 1 Age distribution of patients

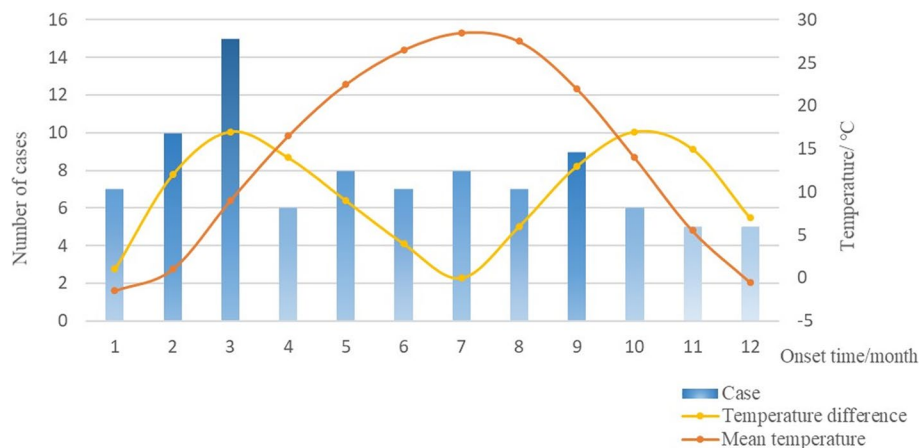


Fig. 2 The relationship between onset time and temperature

5 year-old dogs accounted for the highest proportion of patients (13.8% and 9.6% respectively).

Disease information

The study included 18 cases with neurological dysfunction grade 2, 34 cases were grade 3, 30 cases were grade 4, and 12 cases were grade 5.

The onset time refers to the time when patients presented with relevant clinical signs of thoracolumbar spinal cord disease for the first time. The onset time was grouped by month and most occurred in March, followed by February and October. Comparing the onset time with the temperature in Beijing, March and October are the two months with the largest temperature difference during a year. The average temperature in February and March is about 13 °C lower than that in September and October (shown in Fig. 2).

The number of abnormal intervertebral disks within a single patient ranged from 1 to 8, with an average

of 2.27. Across all cases, disk disease included all the intervertebral disks between T9 and S1, of which T12-T13 accounted for the highest proportion, followed by T13-L1 and T11-T12. The incidence decreased progressively from T12-T13 both cranially and caudally (shown in Fig. 3).

Treatment result and influencing factors

Five cases in the study had received surgery before acupuncture treatment, and only 1 of them (20%) was successfully treated. Among the 89 cases that received acupuncture without surgery, 71 were successfully treated, with a recovery rate of 79.78%. Except for 3 cases related to urinary tract stones, a total of 23 out of 29 IVDH related urinary disorders recovered after treatment. The recovery rate of subjects with urinary dysfunction was 79.31%.

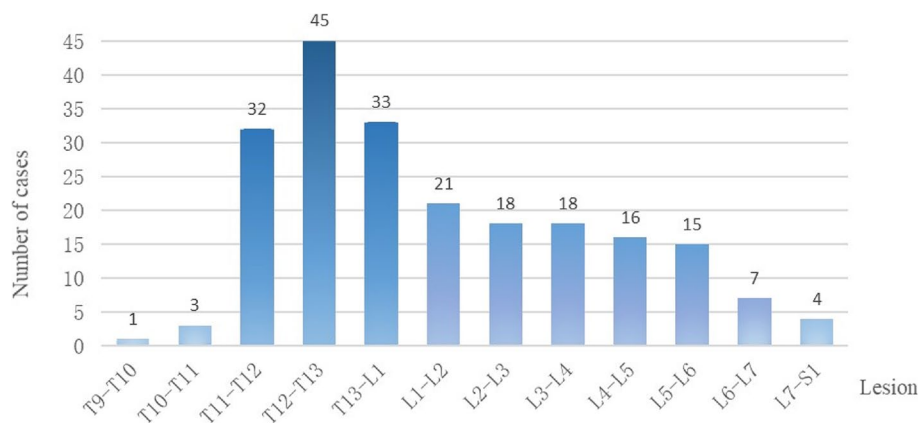


Fig. 3 The distribution of lesions

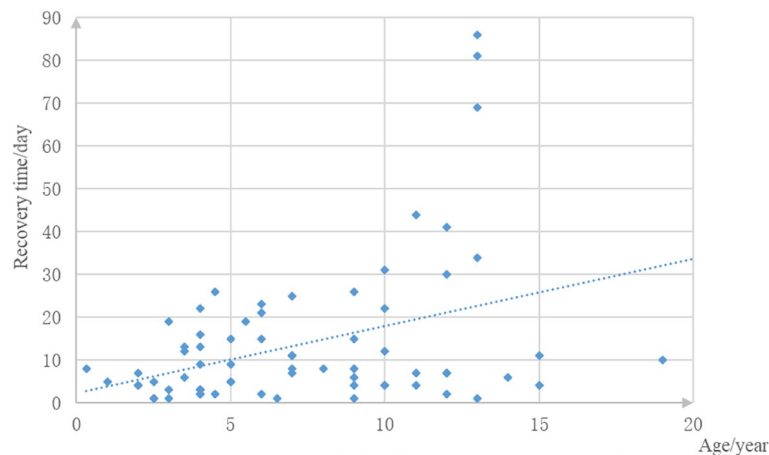


Fig. 4 The relationship between recovery time and age ($P < 0.01$, $r = 0.379$)

Influence of age—For cases that did not receive surgery, there was no significant difference in the recovery rate among different age groups, while there was a significant correlation between the age and the recovery time ($P < 0.01$, $r = 0.379$, shown in Fig. 4).

Table 2 The treatment results of each grade

Grade	Treatment success	Treatment failure	Total	Recovery rate
2	15	3	18	83.33%
3	28	5	33	84.85%
4	23	4	27	85.19%
5	5	6	11	45.45%*
Total	71	18	89	79.78%

* $P < 0.05$ vs. grade 2

Table 3 The Comparison of recurrence and recovery

Type	Recovery rate	Recovery time /day
Recurrence	68.8%	23.82
First onset	82.2%	11.73

Table 4 Treatment frequency and results

Classification	Number of cases	Average treatment duration /day	Average number of treatments /time	Average treatment frequency /day·time ⁻¹
Treatment success	71	13.73	4.30	4.14
Treatment failure	18	37.61	9.94	3.77
Recovery of urination	23	7.48	3.39	2.37
Failure to recover urination	6	23.50	7.33	3.96

Influence of grade—The recovery rates of grade 2, 3 and 4 were basically the same, while they were significantly slower ($P < 0.05$) in grade 5 than in other grades (Table 2).

Influence of relapse—Among patients that did not receive surgery, 16 relapsed. The recovery rate of relapsed cases was slower than that of first onset cases (shown in Table 3), although the difference was not significant. Among those that recovered, there was a significant correlation between recurrence and recovery time ($P < 0.05$).

Influence of treatment frequency—For the cases that did not receive surgery, there was no significant correlation between recovery rate and treatment frequency (shown in Table 4). However, in the cases treated successfully, there was a significant correlation between recovery time and treatment frequency ($P < 0.01$, $r = 0.613$). Patients with a high frequency of treatment recovered faster.

For cases with urinary dysfunction, the average treatment frequency of patients who recovered was once every 2.37 days, and that of patients who did not recover was once every 3.96 days (shown in Table 4). There was a significant difference between these two groups ($P < 0.05$). However, the recovery time of urinary function had no significant correlation with treatment frequency.

Discussion

Influencing factors

According to the results presented, the incidence of canine TL-IVDH is higher in males than in females, which is consistent with the results of previous clinical studies [9]. This difference was most obvious in results published by Wang Lei et al. [10], which suggested that the gender difference was related to the structure of regional dog breeding. However, there is no statistical report on the gender ratio of pets raised in China or Beijing, thus it is impossible to further discuss this conclusion. Epidemiological investigation of lumbar disc herniation in human medicine in China and other countries [11] shows that the incidence rate of TL-IVDH in males is higher than in females, which may be related to the fact that the majority of heavy physical labor professionals are male. Therefore, the gender difference of the disease may be related to estrus of intact male dogs. Behaviors such as straddling and chasing females during estrus, as well as increased aggression due to hormonal changes, may increase the risk of TL-IVDH.

In this study, TL-IVDH was found to occur more frequently in small chondrodysplastic breeds. According to reports outside China, Dachshunds are the breed with the highest incidence of TL-IVDH [9], while Pekingese have the highest incidence based on early studies in China [10]. According to the survey of China Pet Trade White Papers [12], Poodles were the major dog breed in China from 2017 to 2020. Therefore, the difference between the most common breeds in this survey and other studies is mainly related to the preference of keeping dogs across different regions and time periods.

The authors also found that TL-IVDH mainly affects small dogs, which has been reported in an epidemiological study [9]. This body size predilection is linked to genetics and anatomy. Chondrodysplastic breeds such as French bulldog, Dachshund, Pekingese, etc. tend to have small and medium body sizes [1], and carry the FGF4 reverse transcription gene that can lead to intervertebral disc degeneration at an early age [13]. Anatomically, the epidural space in small dogs is relatively small in volume compared to that in medium to large dogs [1], and the same bulge causes more severe spinal cord compression in small dogs.

Non-chondrodysplastic breeds usually develop intervertebral disc degeneration over the age of 7 years [14], but chondrodysplastic breeds usually develop the disease at an early age [15]. This could explain why the age of disease onset in this study tended to be younger in chondrodysplastic breeds than that in dogs without chondrodysplasia.

Time of onset and theoretical analysis of TCVM

The disease of dogs in this study mainly occurred in March, followed by February and October. According to Traditional Chinese Medicine theory, TL-IVDH belongs to *Wei* Syndrome or *Bi* Syndrome, the former of which characterizes pain and the latter typically presents with flaccidity and weakness. The onset of TL-IVDH is the result of the invasion of external pathogens and weakness of the body. If external *Qi* changes too drastically, or arises in mismatching times, the *Qi* will become a pathogen, which easily lead to internal imbalance and therefore, disease. The pathogens related to the onset time of this disease are mainly Cold pathogens that are more likely to invade the body when the temperature suddenly changes. Historical weather records in Beijing showed that the temperature ranges from February to March and from September to October, respectively, were larger than the other time periods of the year, resulting in the predilection of onset time for TL-IVDH. The temperature in February and March was lower than that in September, and the Cold pathogens were more likely to cause the disease, resulting in the highest incidence of TL-IVDH in March.

In Traditional Chinese Medicine the internal cause of this disease is mostly related to the dysfunction of Zang Fu organs. According to the theory of “Kidney governing bone”, kidney deficiency is the main cause of TL-IVDH among all internal causes. According to the relationship between Five Elements, Liver is the child of Kidney, and the hyperactivity of Liver can rob Kidney *Yin*, resulting in deficiencies of Liver and Kidney *Yin*. Based on the Five Element theory, Liver *Qi* rises in spring, and the child steals the mother *Qi*, leading to the weakness of Kidney *Qi* and Blood. Therefore, the incidence is highest in spring compared to other seasons.

Lesion site and influential factors

Disc herniations can occur at any location along the spine. In this study, the highest incidence of IVDH was located in the transitional region of the thoracolumbar spine. One study showed a higher incidence of IVDH between T11-T12 and L2-L3 [16]. Although there are differences of the single lesion site between the previous findings, the incidence of T11-L2 intervertebral space at the thoracolumbar junction is widely regarded as the highest. This is because the ligaments between the intervertebral bodies of T1-T10 are highly developed, while the ligaments between the intervertebral space of T10-T11 are weaker and suffer more stress during exercise [17].

Efficiency of the acupuncture treatment

The recovery rate of cases that did not undergo surgery in this study was 79.78%. According to relevant reports, the recovery rate of acupuncture treatment for canine TL-IVDH ranges from 88% to 90%, and the recovery rate of conservative treatment alone is about 60% [2, 4, 10]. Considering the differences in defining recovery among different studies, it was expected that the recovery rate in this study would be slightly lower than those in the previous reports. For example, some studies considered successful treatment as an occasional ability to stand or walk independently.

According to the conclusions of studies conducted in China and abroad on the application of acupuncture treatment for postoperative TL-IVDH cases, treatment outcome can be affected by multiple factors such as the timing of surgery, the presence or absence of deep pain perception, and postoperative management [17], but there is no evidence to confirm their correlations. A randomized, double-blinded, prospective clinical trial [18] comparing the rehabilitation timing after acute TL-IVDH spinal decompression surgery in 30 affected dogs found that receiving acupuncture treatment early or late had no significant effect on the recovery of walking ability. According to the current literature [9, 10, 19–21], the effectiveness of acupuncture treatment in postoperative cases is often inferior to that in non-postoperative cases, and its effectiveness is variable.

In addition to using recovery status of walking as an evaluation standard to eliminate the subjective factors in the evaluation of recovery status, urinary dysfunction is also evaluated for its impact on the life quality of the affected dogs and their owners. The recovery rate of urinary dysfunction in this study was similar to the data of Hayashi Ayne Murata et al's study [2] (8/10), which was better for dogs receiving acupuncture than that of conservative treatment alone (6/12).

Impact factors of the acupuncture treatment

Grading—At present, a large number of studies generally regard deep pain perception as the most important prognostic sign for evaluating the likelihood of functional recovery in IVDH dogs [16]. Similar to that report, this study used neurological dysfunction grade as the grading standard. The recovery rate of grade 5 patients with loss of deep pain was 45%, which was significantly lower than in other grades. In a previous study on the treatment effect of surgery on TL-IVDH, the postoperative effective rate in dogs with deep pain reached 85%~95% [20], but the effective rate of dogs without deep pain was only 58% [16]. Statistical inference from many reports show that acupuncture treatment for dogs with TL-IVDH has a significant effect

in patients of grade 2~3, with an effective rate of up to 90%, while the recovery rate is reduced to 40% in patients of grade 4 and above [20]. Based on current research data on the efficacy of treatment methods for IVDH in dogs, it can be inferred that the difference in treatment effects of acupuncture for IVDH is mainly due to the presence or absence of deep pain perception in dogs.

Age—In this study, the older the patients were, the slower the rate of recovery recovered. Liu Ching Ming et al's retrospective study [20] showed that age had no significant effect on the prognosis of acupuncture treatment in IVDH patients. However, other studies [21] have confirmed that the treatment efficiency of canine IVDH is affected by age, and the older the affected dog, the lower the recovery rate. Based on the results of this study and previous studies, it can be concluded that the age of affected dogs still has some influence on treatment results. In TCVM, it can be explained that as a dog ages, the function of *Zang Fu* organs gradually decreases. *Qi*, Blood and *Jing* gradually attenuate and become insufficient to nourish the whole body. In addition, when getting older, the deficiency of *Qi* makes it more difficult to restore the balance of *Yin* and *Yang*.

Recurrence—Research studies have focused on the different treatment methods and the recurrence rate of different types of IVDH, but no comparative study on treatment effect on recurrence has been reported. In this study, the recovery rate of relapsed cases is lower than that of first onset cases. However, Wang Lei [10] reported that 15 recurrence cases receiving acupuncture treatment had an effective rate of 93.3%, which is equal to those of other studies.

Frequency of the acupuncture treatment—At present, published experimental studies mostly use fixed treatment frequency to control the experimental variables and improve the reliability of the conclusions. However, the frequency of treatment mainly depends on the compliance of the pet owner in clinical treatment. As a retrospective study with a large time span, it was difficult to include and exclude cases according to the frequency of treatment. However, the situation enables this study to explore the effect of acupuncture frequency on the therapeutic effect. According to data analysis, the frequency of treatment mainly affected the length of time it took for the patient to begin to walk. In terms of urination function, it mainly affects whether the urination function can be restored.

Acupoints selection

According to TCM pathogenesis, the main cause of TL-IVDH is the obstruction of pelvic *Tai-yang* Bladder and

the *Du* Channel due to the deficiency of Kidney *Qi* and the invasion of external pathogens. Therefore, acupuncture treatment aims to increase blood circulation, remove blood stasis and tonify Liver and Kidney.

Local acupoint selection mainly includes points on *Du* Channel, Bladder Channel and *Jia-ji* points around the lesion site. For example, when the lesion is located at L2-L3, GV4 (Ming-men) on the *Du* Channel, BL23 (Shen-shu) on the Bladder Channel, and *Jia-ji* point at the same level will be selected. The Bladder Channel runs across the waist, around which Back Shu points can regulate and tonify the *Qi* and Blood, treating not only the adjacent areas but also along the channel and affect the hind end. Intervertebral disc lesions and spinal cord injury are governed by *Du* Channel, which can transmit stimulations around the body to regulate overall *Qi* and Blood. *Du* Channel is also the sea of *Yang*, which can control and regulate *Yang*. *Jia-ji* points belong to the extra points, which can support the *Yang* of the *Du* Channel and the *Qi* of the Bladder Channel [19].

According to TCVM theories, intervertebral disc disease is associated with a deficiency of Kidney *Qi*. *Yong-quan* is the *Jing*-well point of Kidney Channel. *Kun-lun* and *Wei-zhong* belong to Bladder Channel that is exterior to the interior Kidney Channel. *Bai-hui* in *Du* Channel can promote *Yang*/*Qi* and tonify Kidney. Urination disorders are some of the main symptoms of this disease, and are the result of *Qi*/Blood Stagnation of the Bladder Channel in meridians theory. From *Zang Fu* pathology, urinary disorders are the embodiment of Kidney *Qi* Deficiency. *Er-yan* and *Hui-yang* in the Bladder Channel and *Hou-hai*, the crossing point of *Du* Channel and Kidney Channel were selected to clear stagnation and regulate Kidney *Qi*. *Liu-feng* and *Wei-jian* belong to the extra points, located at the end of the limbs and tail, respectively. According to the research of modern medicine, stimulating the distal limb can strengthen nerve conduction between the spinal cord and the limb, leading to regeneration of the nerve on this pathway [22]. Because of the sensitivity of the distal limbs, acupuncture can

cause a strong pain response, and restore the movement of *Qi* and Blood. This is why treatment at these points is mostly applied for severe symptoms including poor distal limb sensation.

The age of the affected dog has a certain influence on recovery speed. The maladjustment and deficiency of *Qi* in the elderly leads to slower healing. Therefore, the acupoints *Bai-hui* and *Nao-hu*, where the *Du* and Bladder Channel meet, can regulate the whole body's *Qi*/Blood and functional activities. *Feng-chi*, as the crossing point of the Gallbladder and *Yang-qiao* Channel, is selected to regulate the *Qi* and tonify the *Yang*. Muscle atrophy is common in paralyzed dogs without preventative treatment. The Spleen controls the muscles. In TCM theory, limb diseases are associated with the Spleen and Stomach. Thus, *Zu-san-li*, the *He*-sea point of the Stomach Channel, is selected to nourish *Qi* and strengthen the muscles of limbs.

Conclusion

In conclusion, the total recovery rate of acupuncture treatments in this study was 79.78%, which is significantly higher than that of conservative treatment recovery rates reported in previous studies. Deep pain perception is the most important factor for the efficacy of acupuncture on IVDH functional recovery. Additionally, the age of patients, those with recurrent disease, and the frequency of acupuncture treatments also affected the recovery outcome.

Materials and methods

Animals

The cases collected for this study were patients at the Veterinary Teaching Hospital of China Agricultural University from 2016 to 2021.

Inclusion and exclusion criteria

Inclusion criteria is shown in Table 5. All 94 cases were presumptively diagnosed with TL-IVDH based on medical history, neurological examination and radiography.

Table 5 Diagnostic criteria of thoracolumbar intervertebral disk herniation in dog

Diagnostic method	Examination result
Medical history	1. Had thoracolumbar trauma 2. Had symptoms like back pain or walking disadvantageous in pelvic limb
Neurological examination	1. There were tenderness points near the thoracolumbar spine 2. Showed pain at the spinal nerve distribution area of thoracolumbar region or pelvic limbs 3. There were two or more symptoms of sensory disturbance, reflex change, muscle weakness and muscle atrophy
Imaging examination	1. X-ray radiography showed that intervertebral space was narrow or wedge-shaped, intervertebral foramen was narrow or density increased 2. CT or MRI clearly showed intervertebral disc herniation

The diagnosis could be made if 2 or more examination results were consistent among the medical history and neurological examination, combined with the imaging examination result

Some cases also underwent MRI (10 cases) or CT examination (3 cases).

The exclusion criteria include: (1) Patients with severe systemic diseases and malignant tumors. (2) Patients with other neurological diseases affecting the judgment of symptoms and improvement. (3) The caregiver interrupted the treatment and replaced the treatment method on his own. (4) Death due to any reason unrelated to TL-IVDH during treatment.

Treatment

Before acupuncture treatment, some dogs had received medicine or surgery without improvement. During the process of acupuncture treatment, none of the cases received any other medication to control pain or treat paralysis symptoms.

Acupoints were chosen based on the principle of local and distal acupoint selection as well as selection

according to syndromes. Local acupoints were selected according to the lesion location, whereas distal acupoints were selected according to the neurological dysfunction grade. For patients older than 10 years of age or patients with muscle atrophy, the acupoints for specific treatments were increased respectively (shown in Table 6). Patients were treated with mild reinforcing and attenuating techniques at all the acupoints. Each patient received dry-needle acupuncture treatment 2–3 times per week, with each treatment lasting for 40 min.

Data collected

The data collected from each case included signalment (breed, weight, gender, age), disease information (grade, onset time, lesion location) and treatment information (treatment result, treatment duration, times and frequency).

Table 6 Acupoints selection for acupuncture treatment

Acupoints	Location	Manipulate	Application
GV2~GV9	In the depression between two spinous processes from T7 to S1	Perpendicular insert 0.3~0.5 cun	Select acupoints at the same level of lesion location and two intervertebral spaces before and after it
BL17~BL29	At the same level between two spinous processes, located in the groove between longissimus dorsi and iliocostalis	Perpendicular insert 0.5~1.0 cun	
<i>Hua-tuo-jia-ji</i>	0.5 cun lateral to the acupoint on the Governing Vessel Channel at the same level	Perpendicular insert 0.5 cun	
<i>Bai-hui</i>	In the depression between L7 and S1	Perpendicular insert 0.5 cun	All cases
KI1	Between the third and fourth metatarsals of pelvic limb, underneath the pad	Oblique insert to the palm 0.5~1.0 cun	All cases
BL40	In the center of the popliteal crease	Perpendicular insert 1~1.5 cun	All cases
BL60	On the lateral aspect of the depression between the lateral malleolus of the fibula and the calcaneus	Perpendicular insert 0.5 cun	All cases
<i>Liu-feng</i>	At the skin fold between digits, three for each pelvic limb	Oblique insert to the palm 0.5 cun	Cases of grad 3 to 5
<i>Er-yan</i>	Located on the sacral foramens, two on each said	Perpendicular insert 0.5 cun	Cases of grad 4 to 5
<i>Wei-jian</i>	at the tip of tail	Perpendicular insert 0.1~0.3 cun	Cases of grad 4 to 5
BL35	In the crease lateral to the tail base	Perpendicular insert 1.0 cun	Cases of grad 4 to 5
GV1	In the depression between the anus and the tail base	Perpendicular insert 0.5~1.0 cun	Cases of grad 4 to 5
GV1	In the depression between the anus and the tail base	Perpendicular insert 0.5~1.0 cun	Cases of grad 4 to 5
GV17	On the dorsal midline at the level of the ear bases	Perpendicular or oblique insert 0.5 cun	Cases over 10 years old
GV20	On the dorsal midline at the level of the ear tips	Perpendicular or oblique insert 0.5 cun	Cases over 10 years old
GB20	In the depression between the occipital protuberance and cranial edge of the wings of the atlas, one on each said	Perpendicular insert 0.5 cun	Cases over 10 years old
ST36	Between the lateral aspect of tibia and fibula, at the height of the upper quarter	Perpendicular insert 0.5~1.0 cun	Cases had muscular atrophy

The length of "cun" is decided by individual, the length from elbow to wrist is defined as 12 cun

Grading was based on the severity of neurological dysfunction, ranging from 1 to 5 [2] with each grade defined as follows: Grade 1—pain associated with IVDD without neurologic deficits; Grade 2—subject had proprioception deficits and ambulatory paraparesis; Grade 3—subject had nonambulatory paraparesis with present deep pain; Grade 4—subject had nonambulatory paraplegia with present deep pain with or without urinary dysfunction; Grade 5—subject had nonambulatory paraplegia without deep pain, with or without urinary dysfunction.

Treatment results were divided into successes and failures. According to each neurological dysfunction grade, the following criteria were applied to determine whether a subject was treated successfully:

Grade 1: Resolution of pain. Grade 2: Resolution of pain, improvement in conscious proprioception and ataxia. Grade 3 and 4: Able to walk without assistance. Grade 5: Able to walk without assistance or had return of deep pain perception.

Treatment duration and frequency of each patient were recorded. For a successful case, the duration was the period from the first to the last treatment before recovery. For a failed case, the duration was from the first to the last treatment. Treatment frequency was calculated as the treatment duration divided by the number of treatments during the treatment period.

Statistical analyses

The data were analyzed by SPSS 17.0. Continuous variables were described using the mean \pm standard error. Discrete variables were described by frequency and percentage. Normal data were compared using a one-way analysis of variance. Post hoc analysis was performed using Tukey's test for pairwise comparisons of analysis of variance results. The correlation between the two variables was analyzed using the Pearson correlation coefficient. The results were considered statistically significant if the probability of error was less than 5% ($P < 0.05$), and they were considered very significant if the probability of error was less than 1% ($P < 0.01$).

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Authors' contributions

Q.J.: data curation, investigation and writing. Y.W.: conceptualization, investigation and writing. H.P.: resources and validation. K.F.: supervision. H.X.: supervision. J.L.: conceptualization, validation and supervision. All authors read and approved the final manuscript.

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Availability of data and materials

All data generated or analyzed during this study are included in this article and its supplementary material files. Further enquiries can be directed to the corresponding author.

Declarations

Ethics approval and consent to participate

All animal studies were reviewed and approved by China Agricultural University Laboratory Animal Welfare and Animal Experimental Ethical Committee (Approval ID: Aw81803202-2-1).

Consent for publication

All patient caregivers signed informed consents to publish their pet's medical details in this article.

Competing interests

The authors declare that they have no competing interests. Author Jiahao Lin was not involved in the journal's review or decisions related to this manuscript.

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