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Clinical management of posterior paraplegia in felines

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Abstract
Forty-three paraplegic cases due to spinal trauma with a wide range of neurological deficits of temporary or permanent nature in felines were reported at the Teaching Veterinary Clinical Complex and Department of Veterinary Surgery and Radiology for one year. Individual cases were graded into Groups A (n=23), B (n=10), and C (10) according to the location of vertebral lesions. Three groups were treated with methylprednisolone and cobalamin at different doses and the changes in clinical symptom were recorded. All cats were restricted to cage rest with proper bedding until voluntary ambulation was attained. Cats of Group B and C showed improved condition with quicker recovery in cats of group C. Satisfactory outcome was seen in 12/43 cats. Recovery with some disability, either as persistent urinary bladder dysfunction, conscious proprioception response, or retention of mild ataxia, was noticed in 10/43 cats. 12/43 cats had died at various stage of clinical observation while 9/43 cats had lost contact. Medical management was adequate in the vertebral lesion with stable fractures with Grade 2 and some grade 3 neurological dysfunction associated with lumbosacral and sacro-coccygeal affections. Spinal affections associated with thoracic trauma of grade 4 and 5 neurological symptoms had an unpredictable recovery; few recovered with some disability while most died within a few days of treatment.

Keywords: Methylprednisolone, cobalamin, paraplegia, proprioception, flaccid paralysis

Introduction
Paralysis is the temporary or permanent inability to move one or whole part of the body and paraplegia is the complete loss of motor system of either forelimb or hindlimb. Basing on localisation of spinal trauma in felines, paraplegia is classified into a) UMN of all forelimb (C1-C5) b) UMN of hindlimbs and LMN of forelimbs (C6-T2), c) UMN of hind limbs only (T3-L3), d) LMN of hind limbs only (L4-S5) [1]. The incidence of paraplegia basing on localisation of spinal fracture or luxation are 10.1% (C1-C5), 1% (C6-T2), 54.5% (T3-L3), 36.4% (L4-L7) in felines [2, 3, 4, 5]. Trauma and vehicular accident being the most common cause of spinal cord injuries including luxation, dislocation, fracture leading to paraplegia of one or both hind limbs or forelimbs. Physical neurological examination added with radiography, myelography, computed tomography and magnetic resonance imaging (MRI) are required for accurate identification of neurological diseases. Two orthogonal views in left lateral and ventrodorsal positions are obtained during the diagnosis of spinal cord injury. Pain is an important finding in intervertebral disc disease, spinal trauma, or luxation. The most traumatic conditions of cats include thoracolumbar vertebral fracture and luxation, traumatic ischemia, and disc protrusion. Treatment modalities for spinal cord injury leading to paraplegia includes conservative and surgical options. Conservative treatment in any spinal cord injuries involves initial steroid administration, cage rest or exercise restriction and application of splints and bandages for immobilisation of the joints. The surgical treatment mainly includes application of internal fixation devices such as pins, screws, vertebral stappling and polymethylmethacrylate (PMMA) through reduction, decompression and rigid stabilisation at fracture site [6, 7, 8]. The most important prognostic factor in spinal cord injury is deep pain sensitivity in damaged limbs, and a lack of deep pain awareness indicates a poor prognosis [9]. The main objective of present research is to assess the types of spinal fracture, luxation in the thoracolumbar and sacro-coccygeal area and to evaluate the effectiveness of medical treatment and physiotherapeutic procedures.

Material and Methods

The clinical cases of felines presented for the treatment of posterior paraplegia at the Teaching Veterinary Clinical Complex and Department of Veterinary Surgery and Radiology, College of Veterinary Science and Animal Husbandry, OUAT, Bhubaneswar, for the period from January to November 2021, were included in the present study. The signalment (age, sex, body wt.), aetiology, type of housing and time of presentation were recorded in table-1.

Table 1: The signalment (age, sex, body wt.), aetiology, type of housing and time of presentation

Animal No.	Age group	Sex	Body weight	Type of housing	Cause	time elapsed before
1	Adult	Female	2.70 kg	Domicile	Fall	3 days
2	Sub-adult	Male	2.40 kg	Semi-domicile	Auto	< 24 hours
3	Sub-adult	Male	3.10 kg	Semi-domicile	Auto	< 24 hours
4	Sub-adult	Male	3.20 kg	Non-domicile	Auto	< 24 hours
5	Juvenile	Male	0.90 kg	Domicile	Cat bite	1 day
6	Sub-adult	Female	1.80 kg	Domicile	Fall	1 day
7	Sub-adult	Female	1.60 kg	Non-domicile	Dog bite	2 days
8	Sub-adult	Male	2.90 kg	Semi-domicile	Auto	< 24 hours
9	Juvenile	Female	0.80 kg	Domicile	Fall	1 day
10	Adult	Female	2.20 kg	Semi-domicile	Fall	3 days
11	Adult	Male	3.60 kg	Semi-domicile	Auto	1 day
12	Sub-adult	Female	1.90 kg	Semi-domicile	Auto	2 day
13	Sub-adult	Female	1-2 kg	Semi-domicile	Auto	2 day
14	Sub-adult	Male	<1 kg	Semi-domicile	Dog bite	1 day
15	Sub-adult	Male	2-3 kg	Semi-domicile	Fall	5 days
16	Sub-adult	Male	2-3 kg	Non-domicile	Auto	<12 hours
17	Juvenile	Female	1-2 kg	Non -domicile	Dog	1 days
18	Sub -adult	Male	2-3 kg	Non -domicile	Train	>12 hours
19	Adult	Female	2.40 kg	Domicile	Auto	2 days
20	Sub-adult	Male	1-2 kg	Non-domicile	Auto	>12 hours
21	Adult	Female	1-2 kg	Semi-domicile	Auto	5 days
22	Semi-adult	Male	1-2 kg	Non-domicile	Fall	2 days
23	Semi-adult	Female	1-2 kg	Semi-domicile	Auto	< 12 hours
24	Sub-adult	Female	1-2 kg	Non-domicile	Auto	2 days
25	Juvenile	Male	1-2 kg	Domicile	Auto	>48 hours
26	Juvenile	Male	< 1 kg	Non-domicile	Fall	<12 hours
27	Juvenile	Male	1-2 kg	Domicile	Fall	>48 hours
28	Juvenile	Male	1-2 kg	Non-domicile	Fall	>12 hours
29	Sub-Adult	Male	>3 kg	Non-domicile	Dog	2 days
30	Juvenile	Male	<1 kg	Non-domicile	Auto	>12 hours
31	Adult	Male	2-3 kg	Semi-domicile	Auto	>48 hours
32	Adult	Male	1-2 kg	Domicile	Auto	>12 hours
33	Juvenile	Male	1-2 kg	Semi-domicile	Fall	<12 hours
34	Sub-adult	Male	2-3 kg	Domicile	Auto	>48 hours
35	Sub-adult	Female	2-3 kg	Semi-domicile	Dog	>48 hours
36	Adult	Male	<1 kg	Semi-domicile	Auto	>48 hours
37	Juvenile	Male	2-3 kg	Semi-domicile	Auto	>12 hours
38	Sub-adult	Female	<1 kg	Semi-domicile	Fall	<12 hours
39	Sub-adult	Female	>3 kg	Semi-domicile	Auto	>48 hours
40	Sub-adult	Male	1-2 kg	Domicile	Auto	>12 hours
41	Sub-adult	Male	>3 kg	Semi-domicile	Dog	>48 hours
42	Sub-adult	Male	>3 kg	Semi-domicile	Fall	>48 hours
43	Sub-adult	Male	2-3 kg	Semi-domicile	Dog	>12 hours

Physical examination of these cats including palpation of vertebral column, concomitant injuries, urinary bladder expression test and neurological examination such as attitude, ambulatory status and gait, proprioception, muscle tonicity, deep pain sensation, withdrawal reflex, patellar, panniculus and perineal reflex in hindlimb was recorded and shown in fig.1

Fig 1: Cats with flaccid paralysis and posterior paraplegia and radiograph showing concomitant injuries of intestinal hernia and sacro- coccygeal vertebral fracture.

The radiographs were analysed to localise the site of spinal trauma, stability and degree of dislocation. In doubtful cases, Cervical myelography is the 1st line of choice to localize the spinal lesion which cannot be visualized in plain radiographs in nonambulatory paraplegic cats. Positive contrast agent Iohexol 300 mg I/ml was used as radiographic contrast agent at approximate level of 0.5ml/kg body weight. Radiographic contrast agent was thawed with water to 37 °C which helps to reduce the viscosity before administration which can help in lowering the post administration seizures. Animal was anesthetized with induction anaesthetics by a cocktail mixture of ketamine and xylazine and maintained with slow I/V infusion of Ringers Lactate at the rate of 5ml/kg bwt/min. Two orthogonal radiographs were taken before contrast agent was administered (Fig 2).

Fig 2: Cervical myelography in cat done using spinal needle and Iohexol 300 mg I/ml

The paraplegic cats were divided into three groups (group A, B and C) and study design was done with different treatment option as follows
Group A- Thoracic spinal affections from T6-T13.
Group B- Lumbosacral spinal affections from L1-S1.
Group C-Sacro-coccygeal spinal affections from S5-C2.

The paraplegic cats were divided into three groups (group A, B and C) and study design was done with different treatment option as follows

Group	Numbering of animals	Treatment option
Group A (T6-13)	A1 to A23	Methylprednisolone sodium succinate @ 30 mg/ kg IM as loading dose, followed by 15 mg/kg body wt 8 hourly for 2 days. Tapering doses of 10 mg/kg twice a day for 2 days and finally 10 mg/kg once a day for 3 days. (Total 7 days). Supportive therapy of Cyanocobalamin @ 2 ml/day for 7 days
Group B (L1-SI)	B1 to B10	Methylprednisolone sodium succinate @ 15 mg/kg body wt 8 hourly for 3 days. Tapering doses of 10 mg/kg once a day for next 4 days. (Total 7 days). Supportive therapy of Cyanocobalamin @ 1ml/day for 7 days
Group C (S5-C2)	C1 to C10	Methylprednisolone sodium succinate @ 10mg/kg body wt 8 hourly for 3 days. Tapering doses of 5mg/kg once a day upto 7th day (Total 7 days). Supportive therapy of Cyanocobalamin @ 0.5 ml/day for 7 days

Results

The incidence, breed, age, sex, body wt wise predisposition for paraplegia are presented in Table-1 and physical examination were recorded as follows. Severe pain was recorded in 30 % of the animals and mild pain observed in rest 70%. Tonic urinary bladder was noticed in 19 cats, soft bladder wall was noticed in 11 cats which were easy to express and mixed Bladder was noticed in 8 cats while 5 cats had normal Bladder expression. Classification in to type of neurologic bladder dysfunction revealed more number of cats with spastic NBD (19/43, 44%), flaccid NBD (11/43, 25%), mixed NBD (8/43, 19%) and (5/43, 12%) had normal bladder. 7 cats were affected with concomitant injury. Attitude of the cats were observed and recorded from a distance. Alertness was noticed in 8/43 of cats, 20/43 cats were depressed and 15/43 cats were stuporous. Cats were resistant to move when left alone but tried to move and come closer to their parents when placed with them in smooth surface. Paraplegia was most evident (31/43), followed by paraparesis (7/43) and ataxia in (5/43). The various neurologic deficits were quantified as follows. Except twelve cats, conscious proprioception deficit was noticed in almost all cats. 13 cats have reduced thigh muscle tonicity and 31 have absent deep pain sensation. Withdrawal reflex, patellar reflex, panniculus reflex, and perineal reflex was absent in 31, 8, 34 and 18 cats respectively. Vertebral lesions affecting T6 to C2 vertebrae were recorded in spinal radiographs. Thoracic vertebrae were affected in 23/43 cats, lumbar vertebrae were affected in 10/43 cats and sacrococcygeal vertebra were affected in 10/43 cats. Fracture and luxation localised at the junction between the two different types of vertebrae were considered to be placed in the preceding vertebra type. Compression fracture is the most commonly observed fracture with stable and unstable type followed by vertebral luxation and at last by fracture and luxation. Plain radiography and myelography pictures were recorded at 2, 5, 10, 20 and 40 minutes interval as follows (fig.2).

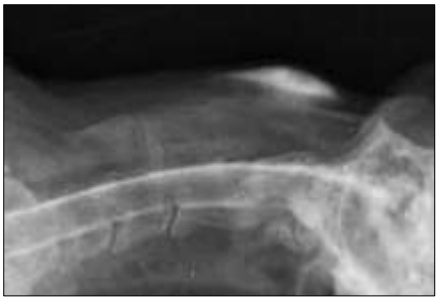

Fig 2: flow of contrast (Iohexol) in the cervical spinal canal indicating absence of spinal trauma in cervical part.

In group A, 14/23 cats had neurological dysfunction of Grade 4, 6/23 cats had Grade 5 NDF while 3/23 cats had grade 3 NDF at the time of presentation. Cats with grade 3 had favorable outcome at the end of observation. Cats with grade 4 showed improvement 15th day post treatment but condition did not improve further. Only 4/23 cats regained voluntary reflex and conscious proprioception. 6/23 cats recovered with some disability like absence of deep pain sensation and occasional voluntary urination, 6/23 cats were unable to contact after the end of observation period. 7/10 cats in group A died at different time interval. In group B, 5/10 cats had grade 4, 3/10 had grade 3 and 2/10 had grade 5 NDF at the time of presentation. Group B cats with grade 3 showed improvement 15th post treatment. Grade 4 cats showed some improvement 30th day post treatment. But overall improvement was seen only with 3/10 cats. 2/3 cats recovered with some disability like neurogenic bladder and absence of conscious proprioception, 4/10 cats died and 1/10 cat had lost contact. In group C, 5/10 cats had grade 2, 4/10 had grade 3

and 1/10 cats had grade 4 NDF at the time of presentation. Group C cats showed immediate improvement 15th day post treatment. 5/10 cats had satisfactory outcome while 2/10 cats recovered with some disability like occasional voluntary urination and reduced perineal reflex causing constipation. 1/10 cat died post the observation period while 2/10 cats could not be contacted. Signs of recovery in cats of group C were observed early cats followed by cats of group B. Majority of cats belonging to group A didn't had eventual recovery. Four cats in group A, three cat in group B and five cats in group C showed satisfactory recovery

Discussion

Myelography allowed for a visual examination of spinal cord compression. The procedure followed were consistent with Ghadiri *et al.* (2015) [10]. This was beneficial in cats with thoracic vertebral fractures and luxation. The procedure for finding the needle insertion site was determined to be precise, and the use of a 27 G spinal needle was sufficient for tapping the cisterna magna in all of the cats without issue. The concentration and dose of iohexol employed were sufficient for occluding the spinal cord. Intravenous fluid delivery was effective in maintaining the animal's hydration state and facilitating the absorption of the contrast agent, as demonstrated by a reduction in the opacity of the contrast column in radiographs taken 40 minutes after injection. Thawing of the contrast agent to 37° was considered to reduce the viscosity. Most common segment of spinal cord injury was thoracic segment 23/43 followed by lumbosacral and lumbar segments with 10/43 each. Five cats of group C had grade 2 while rest five cats grade 3 and grade 4 neurologic dysfunctions. Of the selected 30 cats, 43.3% of the cats had grade 4 neurologic dysfunction. Only 10% of the selected cats suffered from grade 5 neurologic dysfunction. Prognosis was poor among cats having grade 5 neurologic dysfunction. Good prognosis was observed in cats with grade 3 while those having grade 4, recovered with some disability. Grade 3 and Grade 4 together accounted for nearly 73% of the cases. Loss of nociception, according to Weh and Kraus (2007) [11], is a sign of significant spinal cord injury with a poor prognosis for vertebral fractures and dislocations. According to Grasmueck and Steffen (2006) [12], functional recovery following fracture or spinal dislocation with loss of deep pain sensation has a poor prognosis; nonetheless, some animals have recovered motor function and urinary incontinence with proper treatment and care.

All the cats of group B and C were alert by 15th post-treatment day. Posture regained quickly in cats of group C. Group C cats started standing with some support as evident by 15th post-treatment day. Majority of the cats in group A were unresponsive, dull and completely recumbent. Cats belonging to the group B regained ambulation by 45th post-treatment while few required supports for standing. 70% of the cats belonging to group B and C started normal ambulation 45th day post treatment. Perineal reflex and deep pain sensation was regained early in Group B and C throughout the observation period. Spinal reflexes *viz*., withdrawal, patellar and panniculus reflexes gradually improved and normal reflex was noticed by the end of observation period in among the cats of group A and B but could not traceable in group A as recovery was poor. Conscious proprioception response regained quickly in group C cats, however, by the end of observation period 3 cats remain proprioceptive deficits. All Group A cats and 3 cats in group B had deficit. Neurogenic bladder dysfunction did not improve in group A cats and manual pressure was always required to evacuate the bladder two times a day. Micturition reflex was easier to regain in flaccid urinary sphincter in cats of group B and C cats. Voluntary control over urination was regained earlier in case of group C in comparison to cats of group B. Almost all cats of group C started urination on their own 45th day post treatment. At the end of the observation period only one cat in group A, 6 cats in group B and 7 cat of group C attained voluntary urination.

Conclusion

In the present study group, neurological examination was most effective in assessing
severity of spinal cord injury. Radiographs obtained after myelography up to 40 min of observation were useful in assessing extent of external compression on spinal cord. Medical management was effective in treatment of vertebral lesion with stable fractures having grade 2 and grade 3 neurological dysfunction. Cats belonging to any group with grade 2 and grade 3 neurological dysfunction recovered with less disability. Methylprednisolone succinate in different doses is very useful for conservative treatment of spinal trauma in felines.

Abbreviation: UMN- upper motor neuron, LMN-Lower motor neuron, C- Cervical vertebrae, T-Thoracic vertebrae, L-lumbar vertebrae, S- Sacrum

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