4.0 RESULTS

The efficacy of modified spinal stapling and tension band wiring with or without hemilaminectomy for the treatment of traumatic paraplegia in dogs was evaluated and compared with non-surgical treatment over a period of two years and the results were as follows.

4.1 Occurrence

A total of 14,442 dogs were presented to the hospital during the study period of two years of which 47 were cases of traumatic posterior paralysis. Among these 47 cases, 22 (46.81%) were non-descript dogs, eight (17.02%) were spitz, four (8.51%) were German Shepherds, four (8.51%) were Labrador Retrievers, three (6.37%) were Dachshunds, two (4.26%) were Boxers, one (2.13%) was Dalmatian, one (2.13%) was Cocker Spaniel, one (2.13%) was Great Dane and one (2.13%) was Doberman Pinscher (Fig. 46).

The age of dogs with traumatic paraplegia during the study ranged from two months to 13 years and four months. Twelve dogs (25.53%) were between zero and three years of age, 12 (25.53%) were between three and six years of age, 10 (21.28%) were between six and nine years of age, 11 (23.40%) were between nine and twelve years of age, and two (4.26%) were between twelve and fifteen years of age (Fig. 47).

Thirty two (68.09%) of these dogs were males while 15 (31.91%) were females (Fig. 48). The body weights of the dogs with traumatic paraplegia ranged from 3 to 45 kg. The occurrence of traumatic paraplegia in dogs during the period of study is represented in Table 1.

4.2 Aetiology for traumatic posterior paralysis

Among the 47 cases of traumatic paraplegia, 25 (53.19%) were involved in automobile accidents, nine (19.15%) got injured after falling from height and one (2.13%) each got injured after being attacked by man and dogs (Fig. 49). Of the nine dogs that got injured after falling
from height, seven fell from buildings (first floor to third floor) while one
dog with osteodystrophia fibrosa became paraplegic after sustaining a
vertebral fracture following a fall from a table and another dog with
hemivertebrae became paraplegic after falling from a chair and
sustaining a dislocation of vertebrae.

The remaining 11 (23.40%) dogs had sudden onset of paraplegia, but did not have a clear history of external trauma.

4.3 Source of animals for the study

During the study period of two years, 47 clinical cases of traumatic
posterior paralysis in dogs were presented to Veterinary College Hospital,
Bangalore. Among them 18 were selected for the study in three groups of
six dogs each.

In Group I, dogs were presented one day (one dog), four days (two
dogs), five days (one dog), 15 days (one dog) and 25 days (one dog) after
sustaining the injury.

In Group II, dogs were presented one day (one dog), two days (one
dog), five days (one dog), 15 days (one dog), 30 days (one dog) and 47
days (one dog) after sustaining the injury.

In Group III, dogs were presented one day (two dogs), two days (two
dogs), fifteen days (one dog) and 30 days (one dog) after sustaining the
injury.

The data of dogs included in the study in the three groups is given in Table 2.

The dogs that had sustained internal or external spinal cord trauma whose owners did not agree for surgical or non-surgical
treatment due to financial or emotional reasons were not included in the study. Dogs which died or were euthanized upon request by the owners
after surgery or initiation of non-surgical treatment were excluded from
the study. The information of dogs excluded from the study is given in Table 3.

4.4 Physical examination

Pain could be elicited on palpation of the affected part of the spine in all dogs of Group I.

In Group II, one dog did not show any pain on palpation of the vertebral column. In one dog, gross distortion of the vertebral column could be palpated.

In Group III, pain was evinced on palpation of the affected part of the spine in four dogs whereas no sign of pain was seen in the remaining two dogs.

4.5 Clinical examination

4.5.1 Rectal temperature (ºF)

In Group I, the mean rectal temperature ranged from 102.00 ± 0.14 to 102.20 ± 0.13 during the study period.

In Group II, the mean rectal temperature ranged from 101.90 ± 0.16 to 102.60 ± 0.34 during the study period. Two dogs with clinical signs of cystitis had elevated rectal temperature (103.5ºF and 103.8ºF respectively) at the time of presentation. However, the rectal temperatures came down in these dogs following the initiation of antibiotic therapy.

In Group III, the mean rectal temperature ranged from 101.80 ± 0.19 to 102.20 ± 0.07 during the study period.

There was no statistically significant difference in the rectal temperatures between different days of the study within the same groups or between the same days of study of different groups. All the mean values fell within the normal physiological range. The data obtained is tabulated in Table 4.
4.5.2 Heart rate (beats per minute)

In Group I, the mean heart rate ranged from 111.30 ± 2.95 to 112.70 ± 2.68 during the study period.

In Group II, the mean heart rate ranged from 110.70 ± 2.92 to 111.70 ± 2.50 during the study period.

In Group III, the mean heart rate ranged from 116.30 ± 0.95 to 118.30 ± 1.59 during the study period.

There was no statistically significant difference between different days of the study within the same groups or between the same days of study of different groups. All the mean values fell within the normal physiological range. The data obtained is represented in Table 4.

4.5.3 Respiratory rate (breaths per minute)

In Group I, the mean respiratory rate ranged from 26.67 ± 1.56 to 27.83 ± 1.49 during the study period.

In Group II, the mean respiratory rate ranged from 28.00 ± 1.69 to 29.00 ± 1.44 during the study period.

In Group III, the mean respiratory rate ranged from 26.00 ± 1.41 to 28.00 ± 1.39 during the study period.

There was no statistically significant difference between different days of the study within the same groups or between the same days of study of different groups. All the mean values fell within the normal physiological range. The data obtained is tabulated in Table 4.

4.5.4 Bladder function

Palpation of bladder in cystoplegic dogs was helpful in determining whether the spinal cord injuries were of the upper motor neuron (UMN) or the lower motor neuron (LMN) type with respect to bladder function. The UMN bladders were distended and urine could not be freely relieved
from them by pressing them through the abdomen. These animals showed dribbling of urine following over-distension of the bladder, but no free flow of urine was seen. LMN bladders were also distended but could be easily relieved of urine by pressing them through the abdominal wall. These animals showed free dribbling of urine when the bladders were full.

In Group I, three dogs had UMN bladders at the time of presentation while two had LMN and one had normal bladder function. All these dogs had normal bladder function on the 60th post-operative day.

In Group II, five dogs had UMN bladders at the time of presentation while one had LMN bladder. Two female dogs had cloudy urine with flakes of pus on the day of presentation indicating cystitis. In one of them the urine was blood tinged. However, the urine cleared in both dogs in three days after antibiotic therapy was initiated. All these dogs also had normal bladder function on the 60th post-operative day.

In Group III, four dogs had UMN bladders and one had LMN bladder, while one had normal bladder function at the time of presentation. Only four dogs had normal bladder function on the 60th post-operative day. One dog that had UMN bladder on day of presentation had LMN bladder on the 60th day. Another dog that had LMN bladder on day of presentation continued in the same state till the 60th day.

Dogs that showed return of bladder function within the 15th post-operative day, improvement in bladder function was seen within the first three days itself.

The data obtained with respect to bladder function during the study period is depicted in Table 5.
4.6 Neurological examination

Detailed neurological examination of all the dogs was performed and the following data were obtained.

4.6.1 Attitude, posture and gait

In Group I, four dogs were alert at the time of presentation while two were depressed at the time of presentation. All these dogs appeared alert by the end of the study. One of the dogs was recumbent on the day of presentation, but the others assumed a sitting posture when left free. Of these, five dogs could stand on their own by the 60th post-operative day while one could still assume only a sitting posture. All the dogs dragged their hindquarters on the day of presentation. Three of these dogs had normal gait, one had occasional ataxia and one had constant ataxia, while one continued to drag the hind quarters. The findings in attitude, posture and gait in dogs of Group I are recorded in Table 6.

In Group II, one dog was depressed at the time of presentation while the remaining five dogs were alert. All these dogs were recorded as alert by the 60th post-operative day. One of the dogs assumed a recumbent posture while the others could sit on the day of presentation. Five of these dogs could stand on their own while one still assumed a sitting posture on day 60. However, the latter could only assume a recumbent posture on the day of presentation. All the dogs dragged the hindquarters on the day of presentation. Four of these dogs had normal gait on the 60th post-operative day while one still dragged the hindquarters and one had occasional ataxia. The attitude, posture and gait of dogs of Group II recorded during the study are presented in Table 7.

In Group III, two dogs were presented in a depressed state while the remaining four were alert. Five of the dogs were graded as alert and one as depressed by the 60th day after initiation of treatment. Five of the
dogs assumed a sitting posture when left on the ground while one assumed a recumbent posture on the day of presentation. Only two of these dogs could stand on their own on the 60th post-operative day, while one could stand with help and the remaining three could not stand even when helped to their hind legs. All the dogs dragged their hindquarters on the day of presentation. At the end of the study period, one had normal gait, one had occasional ataxia and another had severe ataxia while three dogs still dragged their hindquarters. The observations in attitude, posture and gait are recorded in Table 8.

4.6.2 Locomotor status

All dogs of Group I were paraplegic on the day of presentation. Of these, two were paraparetic while the remaining four became ambulatory by the 60th post-operative day. The recordings of the locomotor status of dogs of Group I are presented in Table 9. The progressive improvement in locomotor status of dogs of Group I is shown in Fig. 50 to 63).

In Group II, of the six dogs that were paraplegic on the day of presentation, five were ambulatory by the 60th post-operative day while one continued to be paraplegic till the end of the study. The recordings of the locomotor status of dogs of Group II are presented in Table 10. The progressive improvement in locomotor status of dogs of Group II is shown in Fig. 64 to 78).

In Group III, of the six paraplegic dogs on the day of presentation two were ambulatory while three remained paraplegic and one was paraparetic by day 60. The findings are tabulated in Table 11. The progressive improvement in locomotor status in Group III is shown in Fig. 79 & 80.

4.6.3 Conscious proprioception

In Group I, none of the dogs had conscious proprioception in the hind legs on the day of presentation. However, five dogs gained conscious
proprioception of the hind legs by the 60th post-operative day while one still had conscious proprioceptive deficit. The recordings of conscious proprioception in dogs of Group I are tabulated in Table 9.

In Group II, conscious proprioception was absent in the hind legs in all dogs on the day of presentation. By day 60 all dogs except one had regained conscious proprioception in the hind legs. The recordings of conscious proprioception in dogs of Group II are presented in Table 10.

In Group III, none of the dogs had conscious proprioception in the hind legs on the day of presentation. Of these, conscious proprioception was recorded in two dogs by the 60th day while the remaining four did not have it. The recordings of conscious proprioception in dogs of Group III are presented in Table 11.

4.6.4 Deep pain sensation

In Group I, all dogs had deep pain sensation in the hind paws at the time of presentation and on all days throughout the study period. The recordings of deep pain sensation in dogs of Group I are presented in Table 9.

In Group II, all dogs except one had deep pain perception in the hind paws at the time of presentation. On day 60 five dogs were recorded as having deep pain sensation in both of the hind paws. The dog that did not have deep pain sensation on the day of presentation had sensation on the left hind leg by day 15. The recordings of the deep pain sensation in dogs of Group II are presented in Table 10.

In Group III, five dogs had deep pain sensation in the hind paws on the day of presentation while one dog did not have it. The status of deep pain sensation remained the same in all the dogs till the end of the study period. The recordings of deep pain sensation in dogs of Group III are tabulated in Table 11.
4.6.5 Spinal reflexes

4.6.5.1 Panniculus reflex

In Group I, one dog appeared to have reduced panniculus reflex caudal to the site of injury on the day of presentation while the other dogs did not have panniculus reflex beyond a level of two vertebrae caudal to the site of injury. Panniculus reflex was normal caudal to the lesion in all dogs on day 60. The findings are tabulated in Table 12.

In Group II, panniculus reflex was absent behind the site of injury in all dogs at the time of presentation. By day 60 five dogs had normal panniculus reflex while one had reduced panniculus reflex. The findings are presented in Table 13.

In Group III, panniculus reflex was absent in all dogs at the time of presentation. Of these, two dogs had normal reflex, two had reduced reflex while in two it was absent by day 60. The findings are presented in Table 14.

4.6.5.2 Patellar reflex

In Group I, five dogs appeared to have increased patellar reflex on the day of presentation while in one it appeared reduced. All dogs had normal patellar reflex bilaterally at the end of the study period. The findings are presented in Table 12.

In Group II, four dogs had increased patellar reflex in both hind legs on the day of presentation, while one had reduced reflex and another did not have patellar reflex at all bilaterally. Of these, all dogs progressed to have normal bilateral patellar reflex by day 60 except the latter which did not show any reflex on the right hind leg while there was a reduced reflex in the left hind leg. The findings are presented in Table 13.

In Group III, four dogs had increased patellar reflex bilaterally on the day of presentation while in one it was reduced and absent in
another. Three dogs had normal reflex, one had increased reflex and the remaining two had absent reflex at the end of the study period. The recordings of patellar reflex in dogs of Group III are shown in Table 14.

### 4.6.5.3 Flexor reflex

In Group I, one dog appeared to have normal flexor reflex bilaterally on the day of presentation, while in two it appeared reduced and in the remaining three it was absent. All these dogs progressed to have normal flexor reflex bilaterally by day 60. The findings are tabulated in Table 15.

In Group II, flexor reflex was found to be absent in four and reduced in two dogs on the day of presentation. Five of these dogs had normal bilateral flexor reflex by day 60. One dog had reduced reflex in the left hind leg while the reflex was still absent in the right hind leg at the end of the study period. The findings are tabulated in Table 16.

In Group III, the flexor reflex appeared to be bilaterally increased in one dog, while it was reduced in two and absent in three dogs at the time of presentation. The reflex was normal bilaterally in three dogs while it appeared to be reduced bilaterally in one dog and absent in the other two at the end of the study period. The findings in flexor reflex in dogs of the three groups during the study period are recorded in Table 17.

### 4.6.5.4 Anal sphincter reflex

In Group I, anal sphincter reflex appeared to be reduced in five dogs while it was recorded as normal in the remaining one dog on the day of presentation. All these dogs had normal anal sphincter reflex on the 60th day. The findings are represented in Table 15.

In Group II, anal sphincter reflex was reduced in five and absent in one on the day of presentation. All these dogs appeared to have normal reflex at the end of the study period except one which had reduced reflex. The findings are tabulated in Table 16.
In Group III, the anal sphincter reflex was normal in one dog, reduced in four and absent in one on the day of presentation. Of these, three had normal, one had reduced and two had absent anal sphincter reflex at the end of the study period. The findings are tabulated in Table 17.

4.7 Grading of patients

In Group I, five dogs were graded 4 while one was graded 3 on the day of presentation. On day 60, four were graded 1 and two were graded 2.

In Group II, five dogs were graded 4 and one was graded 5 on the day of presentation. One was graded 3 while the remaining were graded 1 on the 60th post-operative day.

In Group III, one dog was graded 5, four were graded 4 and one was graded 3 on the day of presentation. On day 60, one dog was graded 5, one was graded 4, one was graded 3, one was graded 2 and two were graded 1.

The details of neurological grading of the dogs on the day of presentation and during the different stages of the study period are given in Table 18.

4.8 Radiographical examination

4.8.1 Plain radiography

Sedation with triflupromazine hydrochloride was adequate for controlling all dogs for survey radiography. Lateral view radiographs were obtained without difficulty in all the dogs. However, ventro-dorsal positioning was difficult in all dogs as the position caused increased pain and discomfort. Extreme care and gentle handling while positioning the dogs for ventro-dorsal view radiographs prevented further damage to the spinal cord and worsening of neurological status.
Vertebral subluxations (4), vertebral body fractures (4), healing vertebral body fracture (1), fracture-subluxations (3), fracture-luxation (1), bilateral cranial articular process fracture (1) and intervertebral disc space reduction (1) were identified on survey radiography of the dogs included in the study. Fig. 81 to 86 show some of the lesions that could be identified on plain radiography. Three dogs included in the study did no have any detectable abnormality of the vertebral column on plain radiographs. Subsequently, these dogs were found to be suffering from intervertebral disc disease on myelography.

Of the 18 dogs included in the study, 14 (77.78%) were identified to have spinal lesions in the region between T₁₁ to L₃ vertebrae. One dog each had lesions affecting T₁₀, L₃, L₅ vertebrae and L₄/L₅ junction. One dog had fracture of L₁ and L₃ vertebrae. The findings of plain radiography are presented in Table 19.

Radiographs taken on the first post-operative day in all dogs included in Group I and II showed that there was adequate reduction of the vertebral segments and proper fixation of the implants.

In Group I, one dog with subluxation at the T₁₂-T₁₃ junction showed progressive formation and consolidation of callus at the site of injury on radiographs obtained during the post-operative evaluation period. The radiographic appearance of the site of injury during the different days of post-operative evaluation is depicted in Fig. 87 to 92. In another dog with bilateral cranial articular process fracture of L₄ vertebra, there was progressive callus formation visible ventral to the intervertebral disc space of L₃ and L₄ vertebrae from the 30th post-operative day. By day 60, a bridging callus had consolidated at the site joining the adjacent parts of the ventral aspect of the two vertebral bodies. Post-operative ventro-dorsal radiographs also revealed that there was progressive callus formation at the fractured articular processes. It was observed by day 60 that the fracture line in the left articular process
was completely filled by callus. On the right side, it was seen that there was healing of the fractured articular process with excess callus formation which bridged the intervertebral disc space between the L3 and L4 vertebrae (Fig. 93 to 96). In one dog with T13 vertebral body fracture, the fracture line was obliterated by callus on radiographs obtained on Day 30. There was progressive callus formation and consolidation at the site of injury and radiographs obtained on Day 60 revealed that the fracture had healed completely with little of extra osseous callus (Fig. 97 & 98).

In Group II, one dog with subluxation at the L1/L2 junction had progressive formation and consolidation of callus at the site of injury during the period of post-operative evaluation. Fig. 99 to 104 depict radiographically visible changes in the site of spinal fixation in this dog on the different days of evaluation. One dog had signs of fracture healing at the L1 vertebral body as it had been presented 47 days after sustaining the injury. Radiographs taken on the day of presentation revealed a small quantity of callus protruding into the floor of the spinal canal from the dorsal surface of the vertebral body. No variation from this condition was seen in subsequent radiographs obtained during the study period in this dog. In one dog which had vertebral subluxation, one dog with compression fractures of vertebral bodies and another dog which had intervertebral disc compression, no radiographically visible change could be appreciated on post-operative radiographs at the sites of injury. Only a mild level of new callus formation was visible at the site of injury in a dog with fracture-luxation involving T11 and T12 vertebrae during the post-operative evaluation period. No radiographically detectable change was observed at the site of hemilaminectomy in any of the dogs throughout the study period.

In Group III, one dog which had compression fracture of L1 and L3 vertebral bodies showed progressive formation and consolidation of
callus at the sites of fracture with extra osseous proliferation of callus throughout the evaluation period. The radiographically visible changes associated with the healing of the fractured vertebrae in this dog are depicted in Fig. 105 to 110. No radiographically visible change was seen in any of the three dogs with intervertebral disc disease throughout the study period. In another dog with fracture-subluxation involving T12 and T13 vertebrae a mild degree of extra osseous callus formation could be observed on radiographs obtained during the post-operative evaluation period. In one dog with fracture of L3 vertebral body and subluxation at L2/L3 junction, the fracture line was found to be filled with callus on day 45 radiographs. However, there was no change at the site of subluxation throughout the study period.

A few post-operative complications could be identified on plain radiography. In Group I, radiographs taken after 15 days of surgery in one dog revealed that the subluxation at T12/T13 junction had recurred (Fig. 111). However, there was no displacement of the implants. In another dog, radiograph taken on day 30 revealed that the cranial spine on which the implant was secured had fractured (Fig. 112). However, there was no displacement of the implant or the vertebrae in this dog also. In Group II, radiographs taken 30 days after surgery in one dog revealed that the “U” shaped K-wire had migrated caudally following fracture of the dorsal spinous process through which it was applied (Fig. 113 & 114).

Among the dogs not included in the study, plain radiography could also identify fractured ribs and pneumothorax in a dog in which fractured ribs could be palpated and pneumothorax was suspected on clinical examination. Other conditions that were recorded on survey radiographs of dogs with traumatic paraplegia included oblique fractures of the vertebral bodies with luxations, hemivertebrae and subluxation,
fracture of the vertebral end plate, ankylosing spondylosis, femoral head luxation and pelvic fractures.

4.8.2 Myelography

Myelography could be performed successfully in all 18 dogs included in the study. The anaesthetic protocol used was adequate for restraining all the dogs for myelography. Diazepam reduced the chances of seizures due to irritation of the tissues of the central nervous system by iohexol.

The method adopted for location of the site for cisterna magna puncture was highly accurate in achieving a successful puncture at the first attempt itself. The 22 gauge, 1.5 inches long hypodermic needles were ideal for puncture of the cisterna magna in all cases. In none of the cases the needle got blocked before the contrast agent could be administered. In one dog of Group II, the needle had to be retracted and re-introduced into the cisterna magna as it had punctured a dural vessel in the first attempt. Collection of cerebrospinal fluid by catching the drops of the fluid as they flowed out of the hub of the needle using a sterile syringe was convenient. All the cerebrospinal fluid samples collected were clear and without visible contamination with blood.

Iohexol at the dose used in the study provided excellent contrast for demarcation of the spinal cord on myelograms. Keeping the dog in a slanted position of about 15° with the head up promoted the caudal flow of iohexol and prevented its flow into the brain.

Myelography was very useful in determining the extent of spinal cord compression in all cases. In Group I, five dogs had complete stoppage of contrast column at the site of spinal injury in myelograms obtained at 10 minutes. In one dog little quantity of the agent had passed the site of injury at 10 minutes. The contrast column did not
pass beyond the site of injury in four of the former dogs, while in one dog the contrast column passed the site of injury with thinning at the site.

In Group II, the contrast column stopped at the sites of injury in myelograms obtained at 10 minutes in five dogs. In two of these dogs the column remained at the site of injury at 30 minutes also. In one dog the contrast agent passed caudal to the site of injury at 10 minutes with signs of spinal cord compression at the site of injury. The contrast columns had passed the sites of injury in myelograms obtained at 30 minutes in the remaining dogs.

In Group III, complete stoppage of the contrast column at the site of spinal injury in myelograms obtained at 30 minutes was observed in three dogs. Two of the other dogs showed passage of the contrast column caudal to the site of lesion at 10 minutes itself while one dog showed caudal passage of the agent in myelograms obtained after 30 minutes with signs of spinal cord compression at the site of injury.

Lateralization of spinal cord compression could not be done in any of the 18 cases. The findings of myelography in dogs of the three groups are presented in Table 20. Myelographic findings in some dogs with traumatic posterior paralysis are shown in Fig. 115 to 120.

None of the dogs in this study showed post-myelographic complications like seizures and all of them had an uneventful recovery from anaesthesia.

4.9 Advanced imaging techniques

Digital radiography, computed tomography and magnetic resonance imaging of the spinal column were performed pre-operatively in one dog. The quality of the digital radiographic images was excellent when compared to the conventional radiographic images (Fig. 121). Computed tomography helped identify fracture lines that could have been easily missed on a conventional or digital radiograph. The actual
shape of the fractures and the extent of spinal cord compression could be visualized clearly (Fig. 122). Magnetic resonance imaging was excellent in determining the actual compression of the spinal cord as the spinal cord was clearly delineated in this technique (Fig. 123).

4.10 Surgical procedure

4.10.1 Pre-operative preparation

Withholding of food and water for 12 hours pre-operatively in dogs of both Group I and II prevented complications like vomition and aspiration during the surgery. The extensive shaving of hair and aseptic preparations prevented contamination of the surgical site during surgery. Pre-operative administration of the antibiotic was helpful in reducing chances of intra-operative infection of the surgical site.

4.10.2 Premedication and anaesthesia

In all dogs of Group I and II, premedication with atropine was adequate for prevention of excessive salivation. Diazepam provided satisfactory muscle relaxation for surgery in all cases. Thiopentone sodium provided adequate anaesthesia for successful completion of surgery in all cases.

4.10.3 Positioning of the dogs for surgery

In Groups I and II, positioning of the dogs on sternal recumbency and securing them in that position by tying the legs to the table with cords, and placement of sand bags on either side of the dogs were adequate to maintain them in the appropriate position throughout the surgery. The pillow made of folded cloth placed below the level of the injured spine under the body of the dogs provided enough stretching and upward curvature of the vertebral column to assist reduce mild displacements of the vertebral column. The maintenance of a constant flow of intravenous fluid helped reduce the chances of dehydration of the exposed tissues at the surgical site during the prolonged surgical
procedure, compensated for the loss of blood during surgery and provided a ready route for intravenous administration of drugs in cases of intra-operative emergencies.

4.10.4 Surgical technique

In both Group I and II, the length of the skin incision was adequate in all cases. The use of dry gauze mops to clear the adipose tissue from the thoracolumbar fascia at the surgical site was effective in preparing a clean area for further surgical dissection. Incision of the fascia on either side of the tips of the dorsal spinous processes and the supraspinous ligaments could be done efficiently with No. 11 BP blade. The supraspinous and interspinous ligaments were not damaged by the surgical process in any of the cases. Periosteal elevators could be easily used to bluntly elevate the epaxial muscles from the vertebral spines, laminae and articular processes. Blunt elevation of muscles prevented unwanted muscular trauma and reduced chances of bleeding from the musculature in both groups. It also provided clear bone surfaces for implant application in both groups and decompressive surgery in Group II. Elevation of the muscles over two vertebrae cranial and caudal to the lesion was adequate in all cases for the application of implants. However, in four dogs one more vertebra was freed of epaxial muscles as fracture lines on the dorsal spine made it appear that fixation of these vertebrae alone may predispose to implant failure. Bleeding during muscle dissection and elevation could be effectively controlled by crushing the small bleeding vessels with artery forceps. However, large bleeding vessels had to be ligated with No. 1-0 catgut. The use of nerve hooks was very useful in preventing damage to the spinal nerves during the dissection. The use of two pronged muscle retractors provided satisfactory retraction of dissected muscles for adequate exposure of the vertebrae during the surgery. Fractures of the dorsal spinous processes and articular processes which were not visible in the plain radiographs
were seen in two dogs of Group II after surgical exposure. Dehydration of the exposed musculature could be prevented by intermittent irrigation with sterile normal saline.

4.10.5 **Reduction of displaced vertebrae**

Reduction of displaced vertebrae was easily achieved manually or by distracting them by holding their dorsal spinous processes with Backhaus towel clamps when the displacement was minimal as in subluxations. In cases with severe displacement of affected vertebrae, lifting of the affected site of the vertebral column by an assistant by raising the abdomen of the animal and simultaneous manipulation of the affected vertebrae helped achieve reduction.

4.10.6 **Modified spinal stapling and tension band wiring**

The selected implants were strong enough for stabilization of the affected vertebral column in all dogs of both groups. The drilling of holes on the dorsal spinous processes was performed with ease using a hand chuck. The drilling of the holes close to the base of the dorsal spinous processes helped anchor the implant to the thickest and strongest part of these processes. However, it was difficult for the holes to be drilled close to the base of the dorsal spinous processes when the thoracic vertebrae were involved. In four dogs, in which fracture of the dorsal spinous processes of the affected vertebrae were seen at the time of surgery, the wires had to be applied carefully below the level of the fracture line and the fixation extended to one more vertebra to reduce chances of implant failure. The “U” shaped implants and the wires could be placed without damage to the supraspinous and interspinous ligaments in all dogs of both groups. The tightening of the figure of “8” tension band wire could be performed with ease using the wire twister-cum-cutter in all dogs.
4.10.7 Hemilaminectomy

Hemilaminectomy could be performed successfully with rongeurs in all dogs of Group II, even though the procedure was difficult especially when the animals were small or the thoracic vertebrae were involved. The procedure was performed on the left side in all dogs as lateralization of spinal cord compression could not be made in any of the cases. Damage to the spinal nerves could be avoided in all dogs except one. In this dog, the spinal nerve got injured while hemilaminectomy was being performed. Removal of the laminae midway into the vertebrae cranial and caudal to the affected intervertebral disc space provided enough exposure and decompression of the spinal cord. The space under the spinal cord could be easily accessed and pieces of bone or intervertebral disc material impinging on the spinal cord could be removed using bone curette and fine mosquito forceps without difficulty. However, deep excavation under the spinal cord was avoided to prevent further damage to the spinal cord and venous sinusoids on the floor of the vertebral canal. Bleeding from the laminectomy site was seen in all cases. Application of bone wax was efficient in controlling the bleeding from the bone whenever excessive bleeding was encountered. Harvesting of free fat graft and its application in the laminectomy defect was performed without difficulty.

4.10.8 Wound closure

The suturing techniques adopted for apposing the dissected muscles and subcutaneous tissue was efficient in preventing dead space in all dogs of both groups. Dead space at the site of fat graft harvest in Group II dogs was also effectively obliterated by means of continuous sutures using 1-0 catgut. Skin sutures could be easily applied with polyamide sutures.
4.10.9 Post-operative care

Seroma formation at the surgical site was a common finding in dogs of both groups. But the condition resolved faster in the dogs of Group I compared to those of Group II. The seromas were also larger in Group II dogs. Small seromas were allowed to get resorbed on their own. Large seromas that persisted for more than four days post-operatively were drained through gaps made at either ends of the suture lines and the subcutaneous space thoroughly lavaged using sterile normal saline solution.

Ceftriaxone was found to be highly effective for the prevention of infection in all of the dogs. However, two dogs of Group II had mild purulence of the accumulated seroma fluid at the surgical site during the first post-operative week. Addition of gentamicin to the normal saline solution used for flushing helped resolution of the condition within three days. The method of dressing adopted was also found to be efficient in keeping the surgical site clean and preventing infection.

Urine could be easily relieved in all of the cystoplegic dogs by pressing the bladders through the abdominal wall. However, in dogs with UMN bladders complete removal of urine from the bladders was often difficult by this method. But, catheterization was generally avoided to prevent chances of introducing infection into the bladder.

Turning of the dogs every two to three hours as long as they were paraplegic and providing soft bedding were effective in preventing formation of decubital ulcers in both groups. The treatment undertaken for the already formed decubital ulcers was effective in preventing infection from setting in and assisting the healing of the ulcers when the dogs became ambulatory. Passive physiotherapy started from the third post-operative day in the form of massaging of the hind limb muscles
and flexion and extension of the joints was highly effective in preventing further atrophy of muscles and keeping the joints mobile.

One dog each of Group I and Group II had severe gastroenteritis at the time of presentation itself and the vomitus and loose fecal matter appeared to have digested blood. Both dogs had received a corticosteroid and/or NSAID before being presented to the College Hospital. Both dogs were administered ranitidine (Rantac®, Ranbaxy Laboratories, New Delhi) at the rate of 0.5 mg per kg body weight intravenously twice daily. The dog of Group I did not respond to ranitidine and had to be administered omeprazole (Omez®, Dr. Reddy’s Lab., Hyderabad) at the rate of 1 mg per kg body weight orally once a day for a further five days until remission of clinical signs was seen. The dog of Group II responded to the treatment and did not have clinical signs of gastroenteritis by 6th post-operative day.

4.10.10 Post-operative complications

In one dog of Group I, inadvertent damage of the spinal nerve during hemilaminectomy caused the abdominal musculature on the left side to be paralyzed. The condition became clearly evident by the 5th post-operative day and persisted as a bulge in the abdominal wall throughout the study period when the dog was sitting on haunches due to paralysis of the abdominal musculature and pushing out of the abdominal contents through it (Fig. 124). None of the dogs of Group II showed signs of neurological impairment due to laminectomy membrane formation during the post-operative period.

4.11 Non-surgical treatment

Ultrasound therapy was performed on alternate days in all the dogs of Group III as per the protocol. However, the requirement of the dogs to be presented frequently for performance of ultrasound therapy was inconvenient for most of the owners. The weekly administration of methylprednisolone acetate epidurally was not associated with any
untoward effect in any of the dogs. The oral administration of B complex vitamins daily was convenient for the owner to be followed.

4.12 Haematological studies

4.12.1 Haemoglobin (g/dl)

In Group I, the mean haemoglobin values ranged from 13.03 ± 0.27 to 13.47 ± 0.19 during the study period.

In Group II, the mean haemoglobin values ranged from 13.15 ± 0.25 to 13.28 ± 0.20 during the study period.

In Group III, the mean haemoglobin values ranged from 13.03 ± 0.19 to 13.25 ± 0.14 during the study period.

There was no statistically significant difference (P<0.05) in the mean values between different days of the study within the same groups or between the same days of study of different groups. All the mean values fell within the normal range. The values obtained are tabulated in Table 21.

4.12.2 Packed cell volume (%)

In Group I, the mean packed cell volume ranged from 39.83 ± 0.49 to 40.83 ± 0.48 during the study period.

In Group II, the mean packed cell volume ranged from 40.00 ± 0.59 to 40.50 ± 0.52 during the study period.

In Group III, the mean packed cell volume ranged from 39.83 ± 0.46 to 40.25 ± 0.48 during the study period.

There was no statistically significant difference (P<0.05) in the mean packed cell volume between different days of the study within the same groups or between the same days of study of different groups. All the mean values fell within the normal range. The values obtained are tabulated in Table 21.
4.12.3 Total erythrocyte count (millions/cmm.)

In Group I, the mean total erythrocyte count ranged from 5.85 ± 0.18 to 6.20 ± 0.07 during the study period.

In Group II, the mean total erythrocyte count ranged from 5.92 ± 0.13 to 6.03 ± 0.11 during the study period.

In Group III, the mean total erythrocyte count ranged from 5.88 ± 0.12 to 6.07 ± 0.07 during the study period.

There was no statistically significant difference (P<0.05) in the mean total erythrocyte count between different days of the study within the same groups or between the same days of study of different groups. All the mean values fell within the normal range. The values obtained are tabulated in Table 22.

4.12.4 Total leukocyte count (thousands/cmm.)

In Group I, the mean total leukocyte count ranged from 16.42 ± 1.66 to 17.99 ± 1.24 during the study period.

In Group II, the mean total leukocyte count ranged from 16.37 ± 1.80 to 20.52 ± 1.76 during the study period.

In Group III, the mean total leukocyte count ranged from 18.13 ± 0.88 to 20.81 ± 1.68 during the study period.

There was no statistically significant difference (P<0.05) between the mean values obtained in dogs of the three groups in any of the days of study. But, the TLC values of dogs of Group I and II, which were on the higher range in the beginning of the study, fell to normal levels by the end of the study period, whereas in Group III the values continued to increase till the end of the study period (Fig. 125). The values obtained are tabulated in Table 22.
4.12.5 Differential leukocyte count (% of individual cells)

In Group I, the mean neutrophil count ranged from 71.17 ± 2.06 to 76.17 ± 2.06 during the study period. The mean lymphocyte, monocyte and eosinophil counts ranged from 18.83 ± 2.06 to 23.67 ± 1.98, 3.33 ± 0.49 to 4.00 ± 0.37 and 1.33 ± 0.21 to 2.50 ± 0.43 respectively.

In Group II, the mean neutrophil, lymphocyte, monocyte and eosinophil counts ranged from 71.17 ± 2.27 to 76.83 ± 2.23, 17.67 ± 1.91 to 23.17 ± 2.33, 3.67 ± 0.21 to 4.17 ± 0.31 and 1.33 ± 0.21 to 1.83 ± 0.48 respectively.

In Group III, the mean neutrophil, lymphocyte, monocyte and eosinophil counts ranged from 76.50 ± 2.20 to 79.17 ± 2.76, 15.33 ± 2.35 to 18.50 ± 2.20, 3.17 ± 0.17 to 4.00 ± 0.26 and 1.17 ± 0.17 to 2.00 ± 0.45 respectively.

There was no statistically significant difference (P<0.05) between the mean values of neutrophils and the lymphocytes between Groups I and II throughout the study period. However, there was statistically significant difference (P<0.05) between the means of neutrophils and lymphocytes of dogs of Group I and II, when compared to those of Group III on day 45 and day 60 of the study (Fig. 126 and 127). The basophil values were not subjected to statistical analysis as they were rare and mostly none of these cells were seen in the blood samples examined. The values obtained are tabulated in Table 23.

4.13 Serum biochemistry

4.13.1 Calcium (mg/dl)

In Group I, the mean serum calcium values ranged from 9.73 ± 0.18 to 9.82 ± 0.25 during the study period.

In Group II, the mean serum calcium values ranged from 9.75 ± 0.20 to 9.87 ± 0.20 during the study period.
In Group III, the mean serum calcium values ranged from 9.65 ± 0.22 to 9.75 ± 0.20 during the study period.

There was no statistically significant difference (P<0.05) in the mean values of calcium between different days of the study within the same groups or between the same days of study of different groups. All the mean values fell within the normal range. The values obtained are tabulated in Table 24.

4.13.2 Phosphorus (mg/dl)

In Group I, the mean serum phosphorus values ranged from 4.85 ± 0.26 to 4.98 ± 0.27 during the study period.

In Group II, the mean serum phosphorus values ranged from 4.75 ± 0.28 to 4.95 ± 0.30 during the study period.

In Group III, the mean serum phosphorus values ranged from 4.42 ± 0.31 to 4.53 ± 0.25 during the study period.

There was no statistically significant difference (P<0.05) in the mean values of phosphorus between different days of the study within the same groups or between the same days of study of different groups. All the mean values fell within the normal range. The values obtained are tabulated in Table 24.

4.13.3 Potassium (mg/dl)

In Group I, the mean serum potassium values ranged from 4.40 ± 0.14 to 4.57 ± 0.14 during the study period.

In Group II, the mean serum potassium values ranged from 4.67 ± 0.22 to 4.72 ± 0.26 during the study period.

In Group III, the mean serum potassium values ranged from 4.57 ± 0.18 to 4.63 ± 0.17 during the study period.
There was no statistically significant difference (P<0.05) in the mean values of potassium between different days of the study within the same groups or between the same days of study of different groups. All the mean values fell within the normal range. The values obtained are tabulated in Table 24.

### 4.13.4 Alkaline phosphatase (ALP) (U/L)

In Group I, the mean serum ALP values ranged from 118.30 ± 18.49 to 167.20 ± 35.48 during the study period.

In Group II, the mean serum ALP values ranged from 191.90 ± 56.50 to 259.60 ± 65.94 during the study period.

In Group III, the mean serum ALP values ranged from 95.42 ± 20.96 to 175.10 ± 51.03 during the study period.

There was no statistically significant difference (P<0.05) between the values obtained on different days of the study within the same groups. In Group I and II the values increased to the 30th post-operative day and later it declined till end of study period. In Group III, the mean values of the enzyme increased till the end of the study period (Fig. 128). The values obtained are tabulated in Table 25.

### 4.13.5 Aspartate aminotransferase (AST) (U/L)

In Group I, the mean serum AST values ranged from 41.37 ± 1.84 to 41.70 ± 1.84 during the study period.

In Group II, the mean serum AST values ranged from 40.70 ± 1.65 to 40.98 ± 1.56 during the study period.

In Group III, the mean serum AST values ranged from 40.90 ± 1.85 to 41.25 ± 1.86 during the study period.

There was no statistically significant difference (P<0.05) in the mean AST values between different days of the study within the same groups or between the same days of study of different groups. All the
mean values fell within the normal range. The values obtained are tabulated in Table 25.

4.13.6 Alanine aminotransferase (ALT) (U/L)

In Group I, the mean serum ALT values ranged from 43.87 ± 3.12 to 44.10 ± 3.18 during the study period.

In Group II, the mean serum ALT values ranged from 45.22 ± 2.78 to 45.38 ± 2.94 during the study period.

In Group III, the mean serum ALT values ranged from 42.93 ± 1.94 to 43.17 ± 2.00 during the study period.

There was no statistically significant difference (P<0.05) in the mean ALT values between different days of the study within the same groups or between the same days of study of different groups. The values obtained are tabulated in Table 25.

4.14 Cerebrospinal fluid (CSF) analysis

The mean specific gravity of the cerebrospinal fluid in dogs of Group I on day 0 was 1.004 ± 0.001. The mean cell count (per µl) was 3.33 ± 0.42 and mean total protein (mg/dl) was 17.65 ± 0.76.

In Group II, the mean specific gravity was 1.004 ± 0.001, the mean cell count (per µl) was 2.80 ± 0.58 and the mean total protein (mg/dl) was 17.87 ± 0.93.

In Group III, the mean specific gravity was 1.004 ± 0.001, the mean cell count (per µl) was 2.83 ± 0.31 and the mean total protein (mg/dl) was 18.20 ± 0.45.

There was no significant difference (P<0.05) between the values obtained in dogs of the three different groups and all the means fell within the normal range. The colour, clarity and cell type present in the CSF samples were also found to be normal in all dogs. The data obtained is tabulated in Table 26.