3.0 MATERIALS AND METHODS

The objective of the present study was to evaluate the efficacy of spinal plating with and without laminectomy and non-surgical treatment for traumatic posterior paralysis in dogs presented to Veterinary College Hospital, Hebbal, Bangalore.

3.1 Occurrence

The occurrence of traumatic posterior paralysis in different breeds, age groups and sex of dogs were recorded.

3.2 Source of animals

The study was conducted on 18 dogs of different age, sex, breed and body weight brought to the College Hospital with paraplegia of traumatic origin. The dogs with traumatic injury of the spinal cord of external origin viz., automobile accidents, falling from heights, attack by humans or animals and blunt objects falling on them, and traumatic injury of internal origin subsequent to intervertebral disc extrusions or protrusions were included in the study.

All the dogs presented with traumatic posterior paralysis were subjected to detailed evaluation as hereunder and they were allotted to the appropriate treatment groups.

3.3 Patient evaluation
3.3.1 Case history

History and observations narrated by the owner were recorded to determine the possibility of involvement of the spinal cord.
3.3.2 Physical examination

Vertebral column, bones of the limbs and pelvis were palpated to detect abnormalities. The spinal columns were palpated from caudal to cranial direction to detect any gross abnormality (dimp like depression) of the vertebrae and to detect pain response from the animals.

The urinary bladder was palpated through the abdominal wall to assess the bladder function. Cystoplegic dogs were graded as having lower motor neuron bladder or upper motor neuron bladder based on whether urine was freely relieved or not when the bladder was pressed through the abdominal wall. Presence of voluntary urination with occasional dribbling or normal urination was also noted.

3.3.3 Clinical examination

All the dogs were subjected to a detailed clinical examination. Temperature (°F), heart rate (beats/min) and respiratory rate (breaths/min) were recorded.

3.3.4 Neurological examination

Following parameters were recorded on detailed neurological examination.

**Attitude, posture and gait:** The general attitude of the dogs were recorded as alert, depressed or stuporous. Posture assumed by the dogs when left on the floor was noted and recorded as recumbent, sitting, or standing with or without help. The dogs were allowed to move on their own to detect abnormalities in gait such as dragging of hindquarters, ataxia, occasional ataxia or whether they had a normal gait. Movements were avoided if a gross abnormality of the vertebral column was appreciable on physical examination.

**Locomotor status:** The locomotor status of the dogs was evaluated based on the observations of the owner and after attempting to make them to move on the floor. However, care was taken to avoid excessive movements of the vertebral column to
prevent further damage to the spinal cord. When a gross abnormality of the vertebral column could be detected on presentation, no attempt was made to make the animal move about to prevent aggravation of the spinal cord injury. Based on the observations, the dogs were classified as paraparetic, tetraparetic, paraplegic, tetraplegic or hemiplegic. Only paraplegic dogs were selected for the present study.

**Conscious proprioception:** The dogs were lifted and their paws turned backwards to make the dorsal surface of the paws to touch the ground (Fig. 11). The ability of the animal to return the paws to the normal position (conscious proprioception) was assessed and recorded as present or absent.

**Deep pain sensation:** Deep pain sensation was assessed by pinching the toes with an artery forceps (Fig. 12). Based on the behavioural response of the animal, deep pain sensation was recorded to be present or absent.

**Panniculus reflex:** This was tested by pinching the skin on either side of the dorsal midline over the lumbar spine with fine forceps in a caudal to cranial direction and observing the twitch of the cutaneous trunci muscle on the ipsilateral and the contralateral sides (Fig. 13). The response was recorded as normal, reduced or absent.

**Patellar reflex:** The patellar reflex was tested by placing the dog on lateral recumbency and the limb to be tested held with the left hand in a relaxed position. A knee hammer was used to tap the straight patellar ligament of the knee joint and the jerking of the knee was observed (Fig. 14). The test was repeated on the other side with the dog lying on lateral recumbency on the opposite side. The reflex was recorded as increased, normal, reduced or absent.

**Flexor reflex:** The dogs were restrained in lateral recumbency and the upper hind limb was held in a relaxed position and the toes pinched with fingers (Fig. 15). The ability of the animal to withdraw the paws by flexing the hock and stifle joints was recorded as increased, normal, reduced or absent.

**Anal sphincter reflex:** The perineal and the perianal skin was pinched gently using artery forceps and the ability of the external anal sphincter to contract was recorded as normal, reduced or absent (Fig. 16).
### 3.3.5 Plain radiography

For subjecting dogs to survey radiography, sedation was accomplished with triflupromazine hydrochloride (Siquil®, Sarabhai-Zydus Animal Health Ltd., Vadodara) at the rate of 1 mg per kg body weight intravenously.

Lateral and ventro-dorsal view radiographs of regions of the vertebral column suspected to have lesions were obtained. Lateral view radiographs of the vertebral column were obtained with the dogs on lateral recumbency, with the fore and hind limbs parallel to each other and stretched cranially and caudally respectively. Sponges were used to reduce the curvature of the spine only if the curvature was too much. Ventro-dorsal view radiographs were obtained with the dogs on dorsal recumbency with the fore and hind limbs parallel to each other and stretched cranially and caudally respectively. However, care was taken to prevent overstretching of the vertebral column to avoid further damage to the spinal cord.

### 3.3.6 Myelography

After a day of plain radiography, the patients were subjected to myelography to determine the extent of compression of the spinal cord and to localize lesions. This procedure was undertaken only if the owners consented for the same after being appraised about the risks involved in the procedure. The contrast agent used for myelography in this study was iohexol (Omnipaque®, 350 mg I/ml, Amersham health, Cork, Ireland) (Fig. 17).

An area of skin extending from the caudal aspect of the skull anterior to the occipital protuberance to the level of the axis and extending on either side of the dorsal midline beyond the level of the edges of the wings of the atlas was shaved. The dogs were premedicated with diazepam (Calmose®, Ranbaxy Laboratories Ltd., New Delhi) at the rate of 0.5 mg per kg body weight intravenously and atropine (Atropine sulphate injection I.P., Superb Drugs Private Ltd., Kolkata) at the rate of 0.04 mg per kg body weight subcutaneously. Anaesthesia was induced with a 2.5 percent solution of
thiopentone sodium (Thiosol®, Neon Laboratories Private Ltd., Mumbai) given to effect intravenously. Anesthesia was maintained with a 2.5 percent solution of thiopentone sodium. The volume of iohexol was calculated at the rate of 80 mg of iodine per kg body weight.

The dogs were restrained on lateral recumbency with the dorsal midline of the neck in line with the table edge. The shaved area of the skin was prepared aseptically by applying tincture of iodine. The head was flexed so that the skull was at 90 degrees to the cervical vertebrae. The nose was kept parallel to the tabletop. The outer margins of the wings of the atlas were palpated with the thumb and middle finger of the left hand. The occipital protuberance was palpated with the index finger (Fig. 18). One imaginary line was made to join the outer margins of the wings of the atlas and another line was imagined to run perpendicularly to the first line from the occipital protuberance. A 1.5 inches long 22-gauge hypodermic needle was introduced at an angle of 90 degrees to the skin at a point midway between the occipital protuberance and the point of intersection of the two imaginary lines. The needle was pushed gently through the musculature and finally the subarachnoid space was punctured. The cerebrospinal fluid was allowed to flow out drop by drop. The drops were collected using a sterile syringe as they left the hub of the needle (Fig. 19). After a volume of cerebrospinal fluid equal to the calculated volume of iohexol was collected, the contrast agent was injected slowly into the cisterna magna (Fig. 20). As soon as the administration of the drug was over, the neck was straightened and the dog was positioned so that it was lying at an angle of about 15 degrees with the head up. This position was retained for about 10 minutes and lateral and ventro-dorsal projections of the affected part of the vertebral column were obtained as in plain radiography. The dogs were then placed again at an inclined position as above and similar projections obtained again after 30 minutes from the time of administration of the contrast agent. Subsequently, the dogs were placed on lateral recumbency and allowed to recover from anaesthesia.

3.3.7 Magnetic resonance imaging
Attempt was made to subject the dogs to magnetic resonance imaging based on the owners willing to undertake the same despite the expenses involved.

3.4 Grading of patients
Dogs with spinal trauma were graded on a five-grade scale based on modified Griffith's (1972) neurological scale:

- Grade 1 – Pain only
- Grade 2 – Ataxia, conscious proprioceptive deficit and paraparesis
- Grade 3 – Paraplegia
- Grade 4 – Paraplegia with urine retention and overflow
- Grade 5 – Paraplegia, urine retention and overflow and loss of deep pain sensation

Only dogs with grades 3 to 5 of neurological dysfunction were considered for the present study.

3.5 Grouping of Patients

Following grading of spinal patients, they were allotted in to three groups based on severity of lesion and owner willingness for surgery.

3.5.1 Group I – Dogs under this group were subjected to continuous ultrasound therapy in the region of the affected spine at the rate of 1.5 watts / square centimeters for 10 minutes on alternate days till recovery or for a maximum period of 60 days. They were also put on cage rest and treated medically with methylprednisolone acetate (Depo-Medrol®, O0Pharmacia N.V./S.A., Belgium) administered epidurally at weekly intervals and B complex vitamins (Tab. Neurobion®, Merck Ltd., Goa) twice daily orally. The poor prognosis for neurological recovery in dogs with Grade 5 injury was explained to the owners and these dogs were included in the study only if the owners insisted on surgical or non-surgical treatment to be undertaken on their pets. Otherwise these dogs were euthanized or returned to the owner without treatment based on the desire of the owner.
3.5.2 Group II – Spinal plating without laminectomy: The affected part of the vertebral column was stabilized by Spinal plating without laminectomy.

3.5.3 Group III – Spinal plating with laminectomy: Spinal plating without laminectomy stabilized the affected part of the vertebral column, and laminectomy was performed to achieve decompression.

3.6 Surgical treatment
3.6.1 Pre-operative preparations
3.6.1.1 Preparation of surgical instruments/materials

Bard-Parker (BP) blades (NO 11 and 22), general surgical instruments, Freer periosteal elevators, two pronged muscle retractors, Backhaus towel clamp, bone curette, nerve hook, rongeurs, hand chuck, (Fig.22 & 23). The bone plating instruments used were 2.7 mm round holed bone plates, cancellous screws, screw driver, drill bits, plate benders, screw tap and screw driver (Fig.21).

All the instruments and the implants were sterilized by autoclaving just before surgery. Miscellaneous materials used during the surgery included chromic catgut (Mersutures®, Johnson and Johnson, Mumbai), polyamide sutures (Linex®, Futura Surgicare Pvt. Ltd., Bangalore) and bone wax (Bone wax®, Johnson and Johnson, Mumbai).

3.6.1.2 Patient preparation

Food and water were withheld from all the dogs for a period of 12 hours pre-operatively. The skin over the back from the level of scapula to base of tail was prepared by clipping and shaving. The skin was scrubbed well with soap and water and painted with tincture of iodine. Ceftriaxone (Vetaceph®, Petcare, Bangalore) was injected at the rate of 20
mg per kg body weight intravenously.

All the dogs were premedicated with atropine sulphate at the rate of 0.04 mg per kg body weight subcutaneously and diazepam at the rate of 0.5 mg per kg body weight intravenously. Anaesthesia was induced and maintained with a 2.5 percent solution of thiopentone sodium at the rate of 12.5-mg/Kg body weight given to effect intravenously.

The dogs were placed on sternal recumbency on the operation table with their fore and hind legs secured to the table by means of cords. A pillow made of folded cloths was placed below the level of the injured spine under the body of the dogs to help easy reduction of the fractured or displaced vertebrae. Sand bags covered with sterile plastic sheets were placed on either side of the dogs to retain them on an upright position. The dogs were draped with a sterile drape extending from neck to tail. An intravenous infusion of Ringer lactate solution (Ringer lactate, Albert David, Kolkata) was maintained throughout the period of surgery at the rate of 10ml/kg b.wt./hour.

3.6.2 Exposure of the surgical site

With the dogs in sternal recumbency on operation table, a dorsal midline incision (Fig.24) was made over the three lumbar vertebrae cranial and caudal, with the affected vertebrae located in the center of the incision. The incision was extended in to the subcutaneous fat to the level of thoracolumbar fascia (Fig.25). After incising lumbodorsal fascia (Fig.26) at lateral to the dorsal midline; on the left side, avoiding damage to supraspinous and the interspinous ligaments, the epaxial muscles were bluntly dissected with a scapel handle.

The muscle attachments were severed from the articular processes of the vertebrae and from a set of articular processes cranial and caudal to these. Blunt dissection and lateral retraction of muscle was continued down to the level of transverse processes or rib heads of the vertebrae to be plated (Fig.27). This procedure was undertaken in all the animals. However in Group-III animals in addition to this, deep lumbar fascia was incised even on the right side and epaxial muscles separation to the level of accessory processes was undertaken to facilitate dorsal laminectomy. Care was
exercised to protect the spinal nerves and vessels emerging from the intervertebral foramen. Haemostasis was achieved by crushing bleeding points with artery forceps and by ligation of major bleeding vessels.

3.6.3 Dorsolateral vertebral body plating

After achieving the reduction of displaced vertebrae manually (lifting the abdomen of the animal to raise the site of injury and simultaneous manipulation). The selected length of 2.5mm thick, 2.7mm round holed bone plate was laid on the dorsolateral aspect of the vertebral bodies. The assistant surgeon held the plate in place with digital pressure (Fig.28), while the surgeon drilled a hole with 2mm diameter drill bit (Fig.29) at an angle of 45-60° relative to the spinous processes (Fig.30). On completion of drilling each hole, the depth of the vertebral hole was assessed by inserting K-wire (Fig.31). The proper length cancellous screw was then selected and placed at most caudal hole in the bone plate (Fig.32). Securing plate in this way prevented it from slipping cranial or caudal to its intended position during the remainder of the procedure. After the last screw had been placed, all of the screws were retightened to assure a secure fit of the plate against the vertebrae. For drilling holes to the thoracic spine the tubercle of the ribs and base of accessory processes, and for lumbar vertebrae, the accessory processes and transverse processes were used as landmarks.

3.6.4 Dorsal laminectomy

In Group-III animals dissection and reflection of the muscle were performed on right side of the vertebrae also to expose the entire dorsal aspect, after the application of the bone plate on the left side. The epaxial muscles were reflected to the level below the articular joints.

A laminectomy defect was created dorsally over the affected vertebrae by using large pair of rongeurs (Fig.33). One of the fine rongeur jaw was introduced in to the intervertebral foramen, taking care not to injure spinal nerve, the caudal articular facets of the cranial vertebrae were nibbled away (Fig.34) followed by lamina of the caudal vertebrae. The laminectomy was extended up to caudal articular facets of the affected
vertebrae. The pieces of bone that had entered the spinal canal were removed using mosquito forceps. Bleeding from the cut end of laminectomy site was controlled by digital pressure. Autogenous free fat graft collected from underneath the incised skin was placed in the laminectomy defect to prevent the formation of laminectomy membrane.

3.6.5 Wound closure

The incised thoracolumbar fascia was apposed on the midline using No.1 chromic catgut applied in a simple interrupted fashion. The subcutaneous tissue was apposed in a continuous fashion using No.1-0 chromic catgut. The skin incision was closed using polyamide sutures applied in a simple interrupted fashion.

3.6.6 Post-operative care

Povidone iodine ointment (Betadine®, Win-Medicare Ltd., New Delhi) was applied to the suture line and sterile gauze pads applied with adhesive tapes. Ceftriaxone was administered twice daily intravenously at the rate of 20 mg per kg body weight for five days post-operatively.

The wound was dressed on alternate days by cleaning the suture line with surgical spirit and application of povidone iodine ointment and sterile pads. Whenever mild seroma formation was seen at the site of surgery, it was allowed to resorb on its own.

The bladder was pressed through the abdomen and the urine relieved whenever the dog was cystoplegic, at least three times a day. The dogs were turned every four to six hours during the day till they were able to turn on their own to prevent formation of decubital ulcers. They were also provided soft bedding to reduce pressure on the soft tissue over bony prominences. Already formed decubital ulcers were cleaned twice daily with povidone iodine topical solution and povidone iodine ointment was applied. Passive physiotherapy was started from the third postoperative day in the form of massaging of the hind limb muscles and flexion and extension of the joints for ten minutes twice daily.

3.7 Non-surgical treatment
The skin over the affected part of the vertebral column was shaved to extend over a length of three vertebrae cranial and caudal to the site of injury, and on either side of the midline one inch beyond the level of the lateral margins of the transverse processes. The dogs were placed on sternal recumbency on a table and physically restrained. Ultrasound gel was applied on the prepared skin. The continuous ultrasound therapy machine (Lifesonic-T, Lifeline Systems, Madras) (Fig. 35) was set to 1.5 watts per square centimeters and the time set to 10 minutes. The transducer was placed on the skin over the gel and moved slowly on the dorsal aspect and on either side of the spinal column throughout the prepared area (Fig. 36). The process was repeated on alternate days for a period of two months following initiation of treatment.

The dogs were also administered methylprednisolone acetate epidurally in the lumbosacral epidural space. The skin over the lumbosacral space was prepared aseptically by shaving the hair and application of surgical spirit. The dogs were controlled manually on sternal recumbency on a table with the hind limbs extended forwards. The cranial edges of the wings of the ilia were palpated with the thumb and middle fingers of the left hand, and the dorsal spinous process of the seventh lumbar vertebra palpated with the index finger at the level of a line joining both the wings of the ilia. A 22-gauge 1.5-inch hypodermic needle was introduced at 90 degrees to the skin slightly caudal to the dorsal spinous process of the seventh lumbar vertebra. The needle was advanced until it penetrated the ligamentum flavum. Methylprednisolone acetate was injected at the rate of 2 mg per kg body weight into the epidural space. The location of the tip of the needle in the epidural space was confirmed by the free flow of the drug. The injections were repeated at weekly intervals for a period of two months. All dogs were administered B complex vitamins orally twice daily for a period of two months following initiation of treatment. Further, these dogs were subjected to passive physiotherapy in the form of massaging of the muscles of the hind legs and extension and flexion of the joints.

All the dogs were provided cage rest during the study period.

3.8 Patient evaluation
3.8.1 Clinical observation

Temperature, heart rate and respiratory rates were recorded on the 7th, 15th, 30th, 45th and 60th day.

3.8.2 Neurological evaluation

The dogs were evaluated for improvement in locomotor status, conscious proprioception, reflexes and pain sensation on the 7th, 15th, 30th, 45th and 60th day. Based on their neurological function their grades were reassessed.

3.8.3 Radiographical studies

Lateral and ventrodorsal view plain radiographs of the operated site of the vertebral column were obtained on the day of presentation and on 7th, 15th, 30th, 45th and 60th day to assess the stability of implants and signs of healing at the site of injury.

3.9 Haematological studies

Two milliliters of blood was collected in EDTA containing sterile vials on the day of presentation and on the 7th, 15th, 30th, 45th and 60th days after surgery to evaluate for haemoglobin (g/dl), packed cell volume (%), total erythrocyte count (millions/cmm.), and total leukocyte count (thousands/cmm.) The samples were analyzed with Auto analyzer.

Differential leukocyte count was performed on Giemsa stained blood smears. One hundred cells were counted and the percent of each type of cell obtained as per the procedure described by Benjamin (2001).

3.10 Biochemical studies
Three milliliters of blood was collected in sterile vials and the serum separated and subjected to estimation of serum inorganic calcium (mg/dl), phosphorus (mg/dl), potassium (mg/dl) and serum enzymes like serum alkaline phosphatase (U/L), alanine aminotransferase (U/L) and aspartate aminotransferase (U/L) by spectrophotometric method using automatic analyzer on the day of presentation, and on the 7th, 15th, 30th, 45th and 60th day after surgery or initiation of non-surgical treatment.

3.11 Cerebrospinal fluid analysis

The cerebrospinal fluid collected on the day on which myelography was performed was examined for colour and clarity. Specific gravity was determined using a refractometer as done by Widmer et al. (1992). Cell count (per µl) was performed using a haemocytometer as done by Thomson et al. (1989). Cell type was studied using smears of centrifuged samples to which serum was added and stained with Giemsa stain as described by Benjamin (2001). Total protein content (mg/dl) was estimated using a spectrophotometer.

3.12 Statistical analysis

Data obtained from haematological studies, serum biochemistry and analysis of cerebrospinal fluid were subjected to statistical analysis by One Way ANOVA to compare the values obtained in dogs between different days of study within each group and between same days of study of different groups for significance using the software GraphPad Prism (GraphPad Software Inc., USA).