5.0 DISCUSSION

The efficacy of spinal plating with and without laminectomy for the treatment of traumatic paraplegia in dogs was evaluated and compared with non-surgical treatment in 18 clinical cases and the results are discussed as follows.

5.1 Occurrence

Among the 16,787 dogs presented to the college hospital during the two years period of study, 65 (0.38%) cases were paraplegia of traumatic origin. Chandy (2006) observed that about 0.33 per cent of the cases presented to the same hospital over a two-year period were paraplegic dogs.

The highest breed-wise occurrence of the condition was seen in German Shepherd dogs (24.66%), followed by Spitz (21.53%), nondescript dogs (20.00%), Labrador Retrievers (9.23%), Dachshunds (9.23%), Boxers (4.62%) and one each of Cocker Spaniel (1.54%), Dalmatian (1.54%), Doberman Pinscher (1.54%), Golden Retriever (1.54%), Great Dane (1.54%), Lhasa Apso (1.54%) and Saint Bernard (1.54%). Highest occurrence of paraplegia has been reported by Riaz (2004) in German Shepherd dogs (52.17%). This might be due to breed popularity and higher occurrence of paraplegia due to nontraumatic origin also.

As per the reports of Yovich et al. (1994) and Necas and Sedlakova (1999), the susceptibility of Dachshunds to intervertebral disc disease was 51.0 and 73.2 per cent, respectively. Though Dachshunds are considered to be more prone to the intervertebral disc disease, presentation of six cases (9.23%) with paraplegia in the present study may be due to lesser popularity of this breed in and around Bangalore. This is in line with the findings of Chandy (2006).

Age of occurrence ranged from two and half months to 14 years in the present study. The age of occurrence reported by Chandy (2006) ranged from two months to 13 years and four months. In the present study, the occurrence of traumatic paraplegia in dogs between zero and three years of age was 29.23 per cent. This indicated that younger
dogs were more prone to traumatic spinal cord injury, which may be because of their playfulness. Similarly, higher occurrence of traumatic spinal injuries in younger dogs have been reported by Carberry et al. (1989) who reported the median age of occurrence of the condition in 12 dogs was two years. McKee (1990) observed that among 51 dogs and cats with spinal trauma, 50 per cent of them were less than two years old.

Thirtyeight (58.46%) dogs with traumatic paraplegia were males, while 27 (41.38%) were females. The higher occurrence of the condition in male dogs could be ascribed to preference of people to keep male dogs as pets than female. Chandy (2006) observed higher occurrence of traumatic paraplegia in males (68.09%) than females (31.90%). Higher occurrence of thoraco-lumbar disc disease in males than in females has been reported by many authors (Yovich et al., 1994; Muir et al., 1995; Necas and Sedlakova, 1999).

In the present study, the body weight of the dogs with spinal injuries ranged from 5 to 35 kg. The reported body weight by Chandy (2006) in a similar study also ranged from 3 to 45 kg. Carberry et al. (1989) reported the body weights of dogs included for the study to range from 4.5 to 35 kg.

### 5.2 Aetiology for traumatic posterior paralysis

In the present study highest occurrence of traumatic paraplegia was due to automobile accident (36.92%). This might be due to their nature of enjoying free life on the streets/open spaces immediately when they got unleashed from the tied chains. Carberry et al. (1989) reported 88.24 per cent of spinal injuries in dogs and cats following automobile accidents. McKee (1990) reported 58.82 per cent of spinal trauma in dogs and cats by automobile accidents.

Sudden onset of paraplegia with no clear history of external trauma (30.77%) was the second most cause of traumatic paraplegia in dogs in this study were diagnosed as having intervertebral disc disease either on survey radiographs or on myelograms. Kinzel
et al. (2005) noted that herniation of the intervertebral disc was the most common cause of neurological trauma in dogs.

Falling from height (12.31%) is another important cause of traumatic paraplegia in this study. Chandy (2006) reported 19.15 per cent of spinal cord injuries in dogs due to falling from height. Carberry et al. (1989) observed 5.88 per cent of spinal cord injuries in small animals due to falling from height.

In the present study, five dogs (7.69%) and two dogs (3.08%) got injured after being attacked by man and animals, respectively. Chandy (2006) reported 2.13 per cent injury due to attack by man and dogs. Carberry et al. (1989) also reported a low occurrence of spinal injury due to attack by dogs (5.88%).

Two dogs each (3.08%) had injury due to fight between dogs and sliding under cot. McKee (1990) reported 11.76 per cent of spinal injuries among 51 dogs and cats due to dogfight. In the present study, one each (1.54%) injured due to door crushing and fence jumping. McKee (1990) reported 1.96 per cent of spinal injuries in 51 dogs and cats due to crushing by door.

5.3 Source of animals for the study

In the present study dogs were presented from 4 days to 14 days after the incident of trauma. In the study conducted by McKee (1990), paraplegic animals were presented between less than one day of injury and three weeks of injury. The delay in presentation may be due to unawareness of owners about the treatment options available. Bagley (2000) discussed the importance of early initiation of treatment for spinal cord trauma to improve the prognosis.

Since the study was on clinical cases, getting the cases with similar injuries and duration of illness was difficult, which is required for effective clinical comparison and statistical evaluation. Though the groups were ununiform the study was conducted, as it was clinically inevitable. The study conducted by Laverty et al. (2004) consisted of paraplegic dogs presented within 72 hours of occurrence of paraplegia. Similar selection criteria would have assured more uniformity to the studied groups.

In the present study, allotment of dogs into Group II and III was done randomly, whereas allotment of dogs to Group I was done based on unwillingness of
the owners to subject their dogs to surgery and due to economic considerations. A similar method for selection of dogs to study the efficacy of surgical and non-surgical treatments in dogs with traumatic paraplegia was used by Riaz (2004) and Chandy (2006).

5.4 Physical examination

5.4.1 Palpation of spine
Physical examination by palpation of the affected part of the vertebral column was helpful in tentatively determining the site of vertebral injury based on dimp like structure along with pain elicitation in dogs with fractures or subluxations. This is in line with suggestions of Wheeler and Sharp (1994). However, pain could not be elicited in all dogs with intervertebral disc disease probably due to stable vertebral column at the site of injury.

5.4.2 Bladder function
Out of the 18 dogs studied in the three groups, only two (11.11%) had normal bladder function, twelve dogs (66.67%) had UMN and the remaining four (22.22%) had LMN bladders at the time of presentation. Return of normal bladder function was found in all dogs, except for two dogs each in Group II and III on the 15th day itself. All dogs in Group II and III had normal bladder function by the 60th post-operative day, while the two dogs in Group III continued to have abnormal bladder function till the end of the study period. It was found that improvement in bladder function was seen within the first three days itself in all the dogs that showed return of bladder function within 15 days. Bladder function returned in paraplegic dogs before return of voluntary movements in the limbs or tail. This suggests that return of voluntary urination could be considered as an early clinical indicator for return of neurological function in paraplegic animals. These are in line with the findings of Chandy (2006) in a similar study, but in contrast with the observations of Riaz (2004) who in his study observed return of normal bladder function
by 4 weeks in four dogs subjected to non-surgical treatment and by two weeks in one dog subjected to surgical treatment.

Evaluation of bladder function was found to be adequate in assessing the neurological recovery in all the groups of animals. In all the dogs treated surgically had returned to normal bladder function by 15\textsuperscript{th} day except two each in Group II and Group III and all dogs became normal by the end of the study period except one in group II and group III. With this it could be inferred that non-surgical treatment gives better results only in cases of mild form of spinal cord injuries and in some fractures without instability. While the surgical treatment without decompression was better in cases of severe form of vertebral column instability (Carberry \textit{et al.} 1989).

\section*{5.5 Clinical examination}

\subsection*{5.5.1 Rectal temperature (°F)}

The mean rectal temperature ranged between 101±0.34 to 101.66±3.12, 101.43±0.18 to 102.23±0.08 and 101.22±0.38 to 102.10±0.15 in Group I, II and III respectively during the period of study. The values recorded were within the normal physiological range specified for dogs (Tennant, 1994). The variations were minimal and statistically insignificant. This indicated that neither the paraplegia nor the treatment methods had any effect on rectal temperature. Gage (1968) reported the rectal temperature of 102.2\textdegree F in a tetraplegic dog sustained with a cervical vertebral fracture. Riaz (2004) and Chandy (2006) also observed no significant variation in rectal temperatures in dogs between the days or groups during his study involving surgical and non-surgical treatment of paraplegic dogs.

\subsection*{5.5.2 Heart rate (beats per minute)}

The mean heart rate ranged from 103.00±0.85 to 108.83±0.90, 102.66±0.71 to 106.16±0.47 and 102.66±1.33 to 109.66±1.42 in Group I, II and III animals respectively. The values recorded were within the normal physiological range specified for dogs. The variations were minimal and statistically insignificant. This suggested that neither the paraplegia nor the treatment methods had no effect on heart rates. A similar non-significant variation in heart rates were reported by Riaz (2004) and Chandy (2006).
5.5.3 **Respiratory rate (breaths per minute)**

During the period of study the mean respiratory rate ranged from 16.00±0.68 to 20.00±0.89, 15.50±0.56 to 18.16±0.70 and 16.16±0.79 to 19.50±0.95 in Group I, II and III animals respectively. The values recorded were within the normal physiological range specified for dogs. The variations were minimal and statistically insignificant. This is in accordance with the findings of Riaz (2004) and Chandy (2006).

5.6 **Neurological examination**

The method of neurological evaluation of the patients based on attitude, posture, gait, locomotor status, conscious proprioception and deep pain sensation, was highly efficient in assessing the degree of spinal cord injury and prognostication of the patients. This is in line with the method suggested by Wheeler and Sharp (1994). Studying of spinal reflexes viz., panniculus, patellar, flexor and anal sphincter were also helpful in localization of spinal injuries and in assessing the neurological recovery of dogs throughout study period. McKee (1990) stated that an animal with traumatic spinal injury should be assessed based on neurological examination rather than radiographical findings, as in some cases there was poor correlation between the degree of displacement of vertebrae noted and severity of neurological dysfunction recorded.

Ferreira *et al.* (2002) graded paralytic dogs to have excellent outcome following treatment if they regained the ability to walk without proprioceptive deficits. In the present study, a dog was considered to have recovered completely if it could stand up on its own, ambulate and engage in basic activities like feeding, defecation and urination on its own. Results of neurological examination throughout the study period indicated that dogs of Group I, showed better neurological improvement, as all the six dogs regained normal function when compared to those of Group II, in which only one dog did not recover completely owing to entry of screw into the spinal cord. In Group III, only three animals had recovered, while the other three deteriorated during the study period.

This indicated that non-surgical treatment was only efficient in dogs with no vertebral instability or significant canal compromise like in cases of intervertebral disc disease and sixth lumbar vertebrae fracture in Group I animals, which in turn suggested that some vertebral fractures are also amenable for non-surgical treatment. This is in line
with the conclusions of Carberry et al. (1989). Among the surgical groups, dogs subjected to spinal plating without laminectomy had better neurological recovery when compared to dogs subjected to spinal plating with laminectomy, which indicated that in cases of severe form of vertebral instability or significant canal compromise needs surgery without laminectomy. The additional bone removed from the damaged areas during laminectomy might increase the degree of instability as it destabilises the dorsal compartment and made the internal fixation more difficult. These findings are in agreement with Bagley et al., (2000). However, Chandy (2006) reported better neurological recovery in dogs subjected to spinal stapling along with hemi-laminectomy.

5.7 Radiographical examination

5.7.1 Plain radiography

Lateral view radiographs were obtained without difficulty in all the dogs after sedation. This is in line with the suggestions of Lanz et al. (2000). However, ventro-dorsal positioning was difficult in all dogs as the position caused increased pain and discomfort to the animals.

The identification of vertebral body fractures, luxations, fracture-luxations, Vertebral subluxations, spondylosis and intervertebral disc space reduction were the lesions that could be identified on survey radiographs of the spine of the dogs included in the study. Similar conditions were diagnosed by McKee (1990) and Voss and Montavon (2004) on survey radiographs. However, Carberry et al. (1989) opined that radiographs might be of limited value as prognostic indicators for dogs with spinal trauma as they might not show the maximum displacement that occurred at the time of injury. McKee (1990) and Lanz et al. (2000) opined that inherent stability of any fracture or luxation was difficult to appreciate radiographically.

Among the dogs included in this study, 55.58 percent were identified to have spinal lesions in the region from T_{11} to L_{3} vertebrae. This is in accordance with the findings of McKee (1990) who observed a high occurrence (39.2%) of traumatic spinal injuries in dogs and cats between T_{12} to L_{2}. McKee (1992) reported that among 60 dogs with thoracolumbar disc protrusions, the most commonly affected disc was T_{12}/T_{13}
(33%), with T12/T13 to L1/L2 accounting for 75 percent of all protrusions. Scott (1997) reported that 65 percent of thoracolumbar disc disease among 40 dogs occurred between T12 to L1. Macias et al. (2002) observed that among 99 dogs with thoracolumbar disc disease 69 percent of the affected discs were located between T12/T13 and L2/L3. Voss and Montavon (2004) reported following a study in 22 dogs that 63.64 percent of vertebral fractures and luxations occurred between T12 and L3. The high occurrence of injury in the thoracolumbar junction as in the other studies may be because of the fact that thoracolumbar region forms a junction between mobile (lumbar) and relatively immobile (thoracic) parts of the vertebral column, which makes it highly susceptible to traumatic injury as suggested by Feeney and Oliver (1980) and Lanz et al. (2000). Breit (2002) observed minimal diameters of the spinal canal at L1/L2 junction in large breeds of dogs. The author stressed the occurrence of spinal cord compression most commonly in this region in non-chondrodystrophic large breeds of dogs.

A consistent pattern in the healing of vertebral fractures could not be identified radiographically during the study period. This was in accordance with the findings of Carberry et al. (1989) who reported variable callus formation during healing of vertebral fractures. Moreover, each fracture type was different and could not be expected to heal in a predictable manner. However Progressive formation and consolidation of callus at the site of injury was evident in all the dogs of Group II, three dogs in Group III and one dog in Group I. The other dogs in Group I with intervertebral disc disease showed no radiographically visible change in the affected parts of spine during the period of study. This is in agreement with the findings of Chandy(2006).

5.7.2 Myelography
The anaesthetic protocol used was adequate for restraining all the dogs for myelography. Diazepam might have reduced the chances of seizures due to irritation of the tissues of the central nervous system by Iohexol.

The method adopted in the study for locating the site for successful tapping of cisterna magna, is in line with the method suggested by Wheeler and Sharp (1994).

Iohexol at the dose used in the study provided excellent contrast for demarcation of the spinal cord on myelograms. Riaz (2004) and Chandy (2006) used a similar dose of Iohexol. Keeping the dogs in a slanted position of about 15° with the head up as
suggested by Wheeler and Sharp, (1994) promoted the caudal flow of Iohexol and prevented its flow into the brain. The technique was adequate in all cases in identifying the sites of spinal cord compression.

The technique was useful in identifying the sites of spinal cord compression in cases of intervertebral disc disease, as the accuracy for identification of the condition in plain radiographs has been found to be low as reported by Lamb et al. (2002)

None of the dogs in this study showed post-myelographic complications like seizures and all of them had an uneventful recovery from anaesthesia. This suggests that iohexol is a safe contrast agent for myelography. Wheeler and Davies (1985), Scott (1997), Riaz (2004) and Chandy (2006) have not reported any complications following the use of this agent for myelography.

5.8 Magnetic resonance imaging technique

Magnetic resonance imaging was found to be superior to conventional radiography, as it clearly delineates the site of spinal cord injuries. This is in accordance with the observations made by Gopal and Jeffery (2001). Tartarelli et al. (2005) also opined that magnetic resonance imaging was more accurate for delineating sites of spinal cord compression. Gonzalez and Olby (2006) and Matiasek et al. (2006) used magnetic resonance imaging to diagnose conditions affecting the spinal cord. However, this diagnostic modality could not be used in all cases due to their lack of availability to veterinary patients due to social and economical concerns.

5.9 Grading of patients

The methods of grading adopted during the study period were very useful in prognostication of the patients and in evaluating the progressive improvement in the patients. These are in line with the methods used by Griffiths (1982), McKee (1990) and Kinzel et al. (2005).

It was found that of the six dogs in Group I, all the dogs had almost normal function except for one, which had ataxia. Among the six in Group II, all the dogs had attained normal neurological function except for one, which did not show any
improvement owing to entry of screw into spinal canal. In Group III, only three dogs regained near normal neurological functions. These results again proved that non-surgical management of intervertebral disc diseased dogs and some vertebral fractures without instability only may yield better results. However, it may not help the dogs having severe form of vertebral instability viz., subluxation and luxation.

5.10 Surgical treatment

5.10.1 Preoperative preparations

Preoperative withholding of food and water for 12 hours was effective in preventing complications like aspiration. Aseptic skin preparation, draping of the surgical site and preoperative administration of antibiotics were effective in preventing the infection of the surgical site. The administration of antibiotics preoperatively is in line with observations of Rosin et al. (1993).

Premedication with atropine and diazepam and the induction and maintenance of anaesthesia with 2.5 per cent solution of thiopentone sodium was adequate in controlling the dogs effectively throughout the period of surgery. Positioning and restraining method adopted was convenient and is in agreement with the recommendation of Wheeler and Sharp (1994).

5.10.2 Exposure of the surgical site

Adopted left side approach to the affected region of the spine was convenient and is in line with the observations of Swaim (1971). Length of skin incision made was adequate, subcutaneous blunt dissection, incising the lumbodorsal fascia, severing epaxial muscle attachments and simultaneous retraction gradually down to the level of transverse processes or rib heads, is in accordance with procedure described by Swaim (1971). This effectively prevented unwanted trauma to muscles, reduced the chances of bleeding and cleared the lateral vertebral surfaces for bone implantation. Exposure of affected region of spine effectively identified the articular and transverse processes fractures in two dogs. This is in conformity with the opinion of Carberry et al. (1989).
Bagley et al (2000) recommended surgical treatment for spinal trauma in animals with spinal instability and for cord compression related to exogenous trauma. They stressed the need of individualizing the treatment guidelines as each spinal injury was unique.

5.10.3 Dorsolateral vertebral body plating

The reduction of displaced vertebral segments could be achieved without much difficulty manually or by distracting the adjacent vertebra by holding the dorsal spinous processes with Backhaus towel clamps. Bagley et al. (2000) suggested the use of lamina spreaders and neuromuscular blockage to reduce the fragments in highly displaced vertebral segments.

Adopting the landmarks for drilling holes into the body of thoracic and lumbar vertebra at an angle of 45 to 60° to the dorsal spinous processes was adequate in preventing the entry of screws into the spinal canal in all cases except for one dog in Group II and also to avoid penetration of intervertebral disc spaces. This technique was well supported by the work of Lanz et al. (2000).

Inclusion of three vertebrae cranial and caudal to the fractured one in bone plating to increase the fixation stability was done without any difficulty and is not associated with any untoward effect in any of the dogs. This is in line with observations of Lanz et al. (2000). However, Swaim (1971) had cautioned about the formation of nonphysiological spinal fixation, as if many vertebrae had been fused into one unit.

Length of bone plate and screw size selected were adequate in providing the stabilization of fractured vertebral column in all dogs except for one dog in Group III, in which implant loosening was encountered. This was probably due to frequent falling of animal on its back.

5.10.4 Dorsal laminectomy

Dorsal laminectomy was performed in Group III dogs for spinal cord decompression after the application of fixation devices as recommended by Cook (1992). The technique was performed successfully in all cases using only rongeurs as reported by
Voss and Montavon (1997). Laminectomy helped clear visualization of the spinal cord and increased the accessibility to protruded disc material or bone pieces. Application of digital pressure was efficient in controlling the bleeding from the laminectomy site. Bleeding control and the application of free fat graft at the laminectomy defect was suggested by Muir et al. (1995) and Scott (1997) may have prevented laminectomy membrane formation, as none of the dogs showed complications suggestive of spinal cord or nerve root compression by laminectomy membrane formation.

5.10.5 Wound closure

Suturing patterns adopted were efficient in reducing dead space and facilitated uncomplicated wound healing in all the dogs of Group II and III. This indicated the successful application of the technique.

5.10.6 Postoperative care

Method of wound dressing adopted was effective in keeping the surgical site clean and might have helped in controlling bacterial infection. Ceftriaxone was very effective in preventing infection in all the cases. This is in conformity with the findings of Blass et al. (1988) and Ray Wood (2002), who recommended the use of cephalosporin antibiotics in spinal surgery patients.

Mild degree of seromas noticed in two dogs of Group II and three dogs of Group III were resorbed on their own without any complications.

Removal of urine in dogs with LMN bladders was easy owing to relaxed urethral sphincter, while it was difficult in UMN bladders because of contracted sphincter, which might have prevented free urine outflow. Urethral catheterization was avoided despite the recommendation by Bagley et al. (2000), probably, which might have prevented iatrogenic cystitis in these animals.

Turning of recumbent dogs every four to six hours and providing soft bedding were effective in preventing the formation of or aggravating the existent decubital ulcers. Passive physiotherapy in the form of massage also prevented the atrophy of hind limb
muscles. These measures were in accordance with the recommendations of Bagley et al. (2000).

5.10.7 Postoperative complications

In the beginning of the study, improper identification of anatomical land marks given by Lanz et al. (2000) to place the screws into the bodies of lumbar vertebrae and poor understanding of implantation corridors defined by Watine (2006) for the vertebral bodies of C$_2$ to C$_7$ and T$_{10}$ to S$_1$ might have caused the entry of bone screws into the spinal canal, which resulted in spinal cord damage, which in its turn manifested in the form of dragging of hind quarters through out the study period and also atrophy of hind limb muscles of one dog in Group II.

In two dogs of Group III, whose laminectomy defect was equal to two vertebral body length resulted in refracture at the laminectomy site. Laminectomy defect might have destabilized the dorsal compartment stabilizers. Bruecker (2006a) observed that laminectomies by nature were destabilizing procedures since they mean the loss of important dorsal compartment stabilizers. Loosening of bone plate encountered in one dog of group III could be attributed to frequent falling of animal on its back.

5.11 Non-surgical treatment

The procedure of ultrasound therapy was simple and could be performed without much inconvenience to the patient in a short period of time. Though, the requirement to present the patient on alternate days for the procedure was inconvenient to some of the owners, weekly administration of corticosteroid epidurally and daily administration of B-complex vitamins orally was convenient for the owners.

Thermal effect of ultrasound waves was said to be the major indication for its use, as these could increase the tissue temperatures up to three to five centimeters deep to the skin. Steiss (2004) detailed the use of this technique for rehabilitation of dogs with neurological injuries. Use of physiotherapy along with medical management by using corticosteroids in this study is in agreement with the protocol followed by Hyun Jung et al. (2003). In any of the cases subjected to this non-surgical treatment recurrence was not
found during the study period. However, Levine and Caywood (1984) reported a recurrence rate of 40 per cent in dogs with intervertebral disc disease treated by medical treatment alone, compared to a lower rate of recurrence when treated surgically.

5.12 Haematological studies

5.12.1 Haemoglobin (g/dl)

During the study period the mean haemoglobin values ranged from 11.90±0.11 to 14.20±0.08, 12.50±0.44 to 16.00±0.07 and 12.50±0.09 to 15.60±0.14 in Group I, II and III, respectively. Values of haemoglobin recorded on specific days during the study period were within the normal range specified for dogs (Tennant, 1994). The variations were minimal and statistically insignificant. This indicated that neither the paraplegia nor the type of treatments had effect on haemoglobin values. These observations are in line with the findings of Riaz (2004) and Chandy (2006).

5.12.2 Packed cell volume (%) (PCV)

The mean packed cell volume (PCV) values ranged from 37.88±0.19 to 42.23±0.10, 38.43±0.05 to 43.33±0.08 and 38.25±0.14 to 43.80±0.27 in Group I, II and III, respectively. The variations were minimal and statistically insignificant. This suggested that neither paraplegia nor the type of treatments had effect on PCV values. This is in accordance with the findings of Riaz (2004) and Chandy (2006).

5.12.3 Total erythrocyte count (TEC) (millions/cmm)

The mean values of total erythrocyte count (TEC) ranged from 5.40±0.05 to 6.60±0.12, 5.38±0.16 to 7.11±0.10 and 5.01±0.27 to 6.95±0.18 in Group I, II and III dogs, respectively during the study period. Values of TEC recorded on specified days during the study in different groups were within the normal range specified for dogs (Tennant, 1994). The variations were minimal and statistically insignificant. This showed
that neither the paraplegia nor the type of treatment had effect on TEC. This is in line with observations of Riaz (2004) and Chandy (2006).

5.12.4 Total leukocyte count (TLC) (thousands/cmm)

During the period of study, the means of total leukocyte count (TLC) ranged from 8.70±0.08 to 16.28±0.10, 9.83±0.09 to 17.33±0.12 and 10.38±0.14 to 15.98±0.27 in Group I, II and III dogs, respectively. Values of TLC recorded on specified days in different groups during the study period were within the normal range specified for dogs (Tennant, 1994). The variations were minimal and statistically insignificant. This indicated that neither the paraplegia nor the type of treatments had effect on TLC values. This is in agreement with the findings of Riaz (2004).

5.12.5 Differential leukocyte count (% of individual cells)

The mean neutrophil, lymphocyte, monocyte and eosinophil counts ranged from 68.00±2.67 to 75.66±1.74, 19.66±1.64 to 23.33±1.66, 3.83±0.47 to 4.50±0.61 and 1.16±0.16 to 1.66±0.33, respectively in Group I; 67.00±1.75 to 75.66±2.71, 20.66±0.88 to 23.50±1.23, 3.50±0.22 to 4.66±0.49 and 1.33±0.21 to 2.00±0.36, respectively in Group II, 66.83±1.72 to 81.83±2.90, 19.33±0.91 to 24.33±1.35, 3.66±0.33 to 4.16±0.47 and 1.50±0.22 to 1.83±0.16, respectively in Group III dogs during the period of study. All the mean values of different cells in different groups were within the normal physiological range specified for dogs. The variations were minimal and statistically insignificant. This is in agreement with the findings of Riaz (2004). However, Chandy (2006) found significant variation in the mean values of neutrophils and lymphocytes of the dogs subjected to non-surgical treatment from those of surgically treated on 45 and 60th postoperative days.

5.13 Biochemical studies

Many authors have reported normal serum biochemistry profiles in dogs with spinal cord injury by different etiology (Moore et al., 2000; Sanders et al., 2002; Tidwell et al., 2002).

5.13.1 Calcium (mg/dl)
The mean values of serum calcium ranged from 8.88±0.16 to 10.98±0.06, 8.83±0.14 to 10.78±0.06 and 9.11±0.11 to 11.28±0.19 in Group I, II and III dogs respectively. The levels of calcium values recorded on specified days throughout the study period were statistically insignificant and a similar nonsignificant variation was recorded by Singh et al. (1976) during fracture healing. This is in accordance with the findings of Riaz (2004) and Chandy (2006). No association between serum calcium and paraplegia had been mentioned by Benjamin (2001).

5.13.2 Phosphorous (mg/dl)

During the study period the mean phosphorous values ranged from 3.90±0.10 to 5.21±0.09, 3.95±0.22 to 5.00±0.14 and 3.81±0.09 to 5.16±0.12 in Group I, II and III animals, respectively. The levels of phosphorous values recorded on specified days in different groups were statistically insignificant and a similar nonsignificant variation was recorded by Singh et al. (1976) during fracture healing. This is in line with the findings of Riaz (2004) and Chandy (2006). No association between serum phosphorous and paraplegia had been mentioned by Benjamin (2001).

5.13.3 Potassium (mg/dl)

The mean serum potassium values ranged from 3.96±0.18 to 4.81±0.19, 3.81±0.32 to 4.46±0.52 and 3.98±0.24 to 4.88±0.42 in Group I, II and III animals, respectively. Values of potassium levels recorded on specified days in different groups were statistically insignificant and a similar nonsignificant variation was recorded by Chandy (2006) during healing of vertebral column fractures.

5.13.4 Alkaline phosphatase (U/L)

The mean values of alkaline phosphatase (ALP) ranged from 112.10±2.32 to 138.53±1.85, 111.23±2.69 to 144.38±2.44 and 119.96±2.01 to 144.66±1.70 in Group I, II and III animals respectively. Levels of ALP increased from first postoperative day gradually up to 30th postoperative day in Group II and III, though it was nonsignificant.
However, from 30th postoperative day onwards level of it declined gradually. This rise in the level of ALP could be attributed to muscle and skin trauma (Singh et al., 1976) initially and later on to osteoblastic activity at the fracture site (Benjamin, 2001).

5.13.5 Aspartate aminotransferase (U/L)

During the period of study, the mean serum aspartate amino-transferase (AST) values ranged from 38.78±0.32 to 50.66±1.28, 38.98±0.22 to 5.84±0.64 and 39.88±0.36 to 58.28±0.69 in Group I, II and III animals, respectively. The values recorded were within the normal physiological range specified for the dog. The variations were minimal and statistically insignificant. This showed that the neither paraplegia nor the treatment adopted caused any change in the AST values significantly. Similar observations were made by Riaz (2004) and Chandy (2006).

5.13.6 Alanine aminotransferase (U/L)

The mean values of serum alanine aminotransferase (ALT) ranged from 39.88±0.36 to 5828±0.69, 32.81±0.20 to 45.36±0.24 and 30.03±0.41 to 41.56 in Group I, II and III animals, respectively. The levels of ALT recorded during the study period in different groups were within the normal physiological range specified for dogs. The variations were minimal and statistically insignificant. This showed that neither the paraplegia nor treatment methods adopted had affected the ALT significantly. This is in line with the conclusion of Riaz (2004) and Chandy (2006).

5.14 Cerebrospinal fluid (CSF) analysis

No abnormalities were noted in the colour, clarity and differential leukocyte count (DLC) in any of the CSF samples. The mean values of specific gravity, cell count (Per µl), total protein (mg/dl) and glucose (mg/dl) were 1.004±0.0001, 3.33±0.42, 14.63±0.34 and 52.96±0.70, respectively in Group I; 1.004±0.0003, 4.66±0.76, 18.05±0.26 and 46.90±0.28, respectively in Group II; and 1.004±0.0002, 3.83±1.01, 19.15±0.28 and 52.51±0.25, respectively in Group III. The values of specific gravity, cell count, total protein and glucose recorded in different groups on the day of presentation were within the normal physiological range specified for the dogs. The variations were minimal and
statistically insignificant. This may be due to the fact that the samples were collected from the cisterna magna. Indieri et al. (1980) and Thomas et al. (1990) reported increased abnormalities in the CSF from the lumbar cistern compared to that from the cerebellomedullary cistern due to predominant caudal flow of CSF from the brain to the terminal spinal cord. These findings were in conformity with the findings of Chandy (2006).